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## LIGHTING DATA

BULLETIN LD-159



## Floodlighting

EDISON LAMP WORKS  
OF GENERAL ELECTRIC COMPANY

GENERAL SALES OFFICE  
HARRISON, N. J.

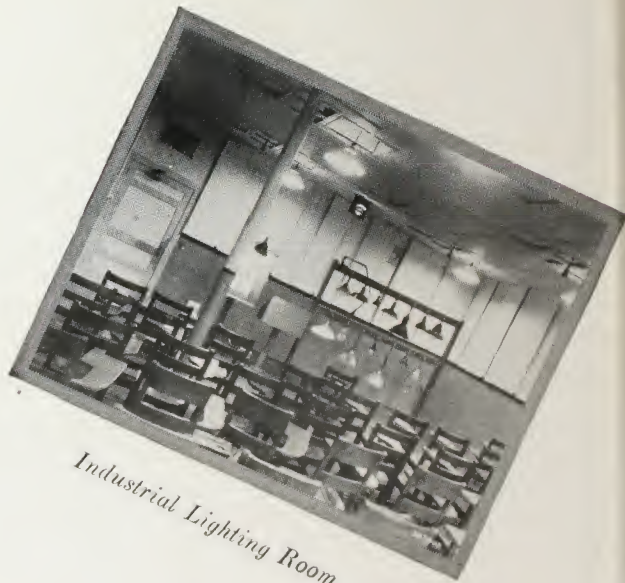




*Where Visitors to the Institute Are Received*



*Model Store of the Institute*



*Industrial Lighting Room*

*At the Edison Lighting Institute, dedicated to the public for the advancement of the art and science of illumination in its many and varied applications, are portrayed most dramatically hundreds of uses of light.*

# FLOODLIGHTING



Terminal Tower,  
Cleveland

ENGINEERING DEPARTMENT  
EDISON LAMP WORKS  
of General Electric Co.



## FOREWORD

*The design of a floodlighting installation requires thought if the result is to fulfill expectations. This bulletin presents a comprehensive design procedure, together with suggestions on floodlighting effects, equipment, and equipment location. A section on the lighting of railway classification yards is included.*



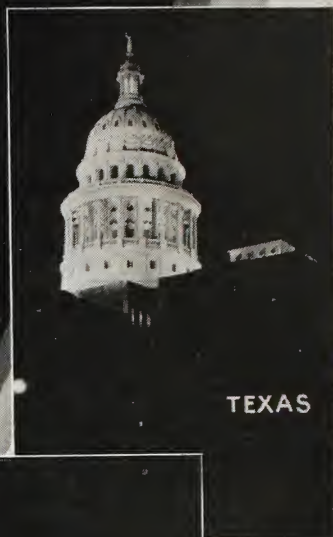
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WASHINGTON D.C.



COLORADO



VERMONT

Floodlighting brings out the beauty of Capitol Buildings in a dignified and pleasing manner



## Floodlighting

Floodlighting serves many purposes. It is a powerful advertising medium to attract attention to office buildings, industrial plants, stores, theatres, and banks; it affords a means of producing artistic and aesthetic effects in the case of fountains, churches, arches, and structures of unusual design; it stimulates civic pride by giving prominence to public buildings, monuments, and statues; it increases the hours of recreation at playgrounds, beaches, toboggan slides, and stadiums; it serves utilitarian and protective purposes in railroad yards, docks, industrial plants, and construction work. Many, indeed, are the uses of floodlighting.

Since floodlighting is employed for such varied services, it is evident that different lighting effects are required for different applications. This is a matter on which definite rules cannot always be laid down; each application requires individual consideration to determine the best lighting effect which can be produced. The beauty and fascination of floodlighting and its latent possibilities bid fair to introduce a new note in architecture to the extent that night lighting will be inherently a building design consideration.

### Effects Sought

Each floodlighting installation should be designed to produce a lighting effect in harmony with the object to be lighted. The following paragraphs present a broad classification of floodlighting applications, together with suggestions on the lighting effects which will be found generally satisfactory in typical cases.

Buildings of simple treatment, or those designed for strictly utilitarian purposes, should usually have uniform illumination, free from sharp shadows, with the light so directed as to give a night-time appearance essentially the same as by day. Floodlighting of this type emphasizes solidity, strength, and mass.

Many modern buildings have setback features or towers or columns of such design that they permit the production of shadow effects and shadings of intensity. When floodlighting these buildings, shadows produced by directing the light almost parallel to the building front can either give an added impression of slenderness and height, or otherwise create magical and unusual effects. The use of color in this connection is often advantageous, and it

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## FLOODLIGHTING

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is in this direction that floodlighting will probably find its greatest field of development. In floodlighting buildings having striking architectural features, the intention should be to emphasize those features.

In many cases, each section of a setback building should be lighted with reasonable uniformity. To obtain such a result it is necessary to direct the larger portion of the projector beams to the top of the section, as the spill light from the units will assist materially in lighting the lower part. Occasionally, where a building has a series of setback sections, the upper portion of each section may be left comparatively dark so that it will stand out in marked contrast with the section above it. The result, while far from the daytime appearance of the building, does give an interesting nighttime effect.

Considering a building as a whole—whether it be of the straight-side or setback type—the illumination at the top should usually be two to four times as great as at the bottom of the building. Not only is more illumination necessary at the top to obtain the same apparent brightness over the whole building, but also from the appearance standpoint a greater apparent brightness is desirable at the top to give the impression of height and to climax the effect.

Columns may be floodlighted in two ways—either the fronts of the columns may be lighted so that they stand out in contrast with the darker recessed area, or the fronts of the columns may be left in darkness to stand out in silhouette against the lighted background. Care must always be taken to avoid a uniformity of illumination over both columns and background, as this destroys the form and depth of the columns and produces the effect of flatness.

In the case of statues and monuments care must be taken to floodlight them in such a way that grotesqueness is avoided, that unnatural highlights and shadows do not produce an altered or distorted appearance. For example, the direction of light will often entirely change the expression of a face, as the accompanying photographs show. The main thought in this application of floodlighting is to produce a play of light and shadows in harmony with the effect desired by the sculptor.

In recreational areas—and in railway yards and buildings under construction, where floodlighting serves a utilitarian purpose—



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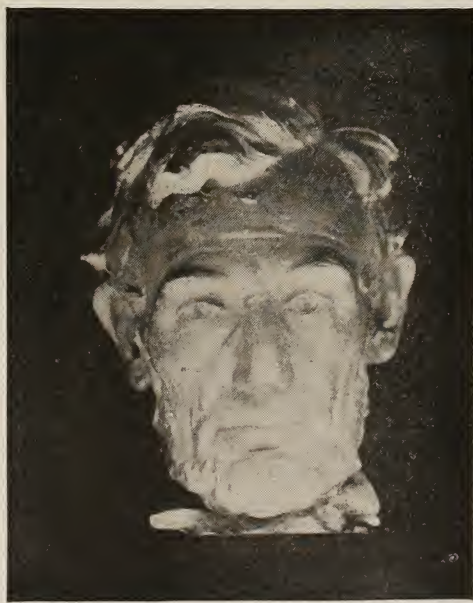
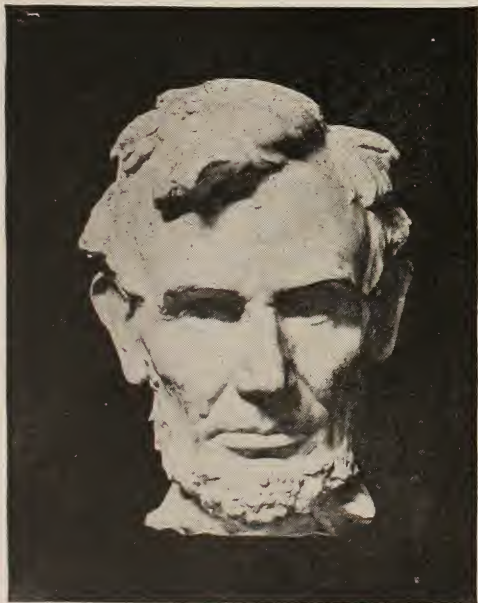
## FLOODLIGHTING

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uniform illumination and freedom from deep shadows are essential. Objectionable glare must also be guarded against, by selecting equipment locations and mounting heights which remove the powerful light sources as far as possible from the normal field of view. The object is to approach the uniformity of daylight illumination, and floodlighting is oftentimes the only recourse where large areas must be kept free of lighting equipment. In this connection it is noteworthy that many outdoor applications such as small recreational areas are best lighted, not by floodlights, but by dome or angle reflectors having mat or semi-mat surfaces, placed comparatively close together at regular intervals around or over the area.

In the majority of floodlighting applications there is a limited range in the locations available for equipment, and the problem is to determine whether equipment located in these available places will give the desired effect. The ingenuity of the designer must be given full sway in arriving at a solution of the problem from among the many possible combinations of equipment, intensity, and color.

In lighting objects which are comparatively small, where the only possible locations for the equipment are a considerable distance away, it may be necessary to employ searchlights with a materially narrower beam than can be obtained with floodlighting equipment.



Natural shadows bring out forcefulness, kindness, and life-like appearance

Reversed shadows give the appearance of fear, or startled surprise

Shadows may make or mar the appearance of a floodlighted statue



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## FLOODLIGHTING

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### FLOODLIGHTING EQUIPMENT

Floodlighting, strictly defined, is the lighting of objects or areas with units having a wide distribution of light and placed close to the objects to be lighted. By common usage, however, floodlighting has come to mean something almost the opposite—namely, the lighting of objects or areas with units having a relatively restricted distribution of light and located at some distance away from the objects to be lighted. Hence it is essential that the reflectors used in floodlighting units have specular reflecting surfaces to control the light and redirect it in well-defined beams.



Typical floodlight projectors employing MAZDA Floodlight lamps



Typical floodlight projectors employing General Service MAZDA lamps



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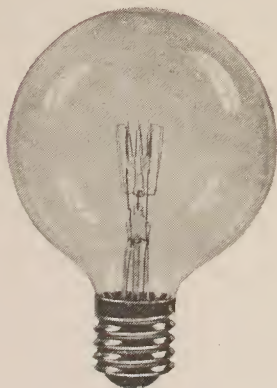
## FLOODLIGHTING

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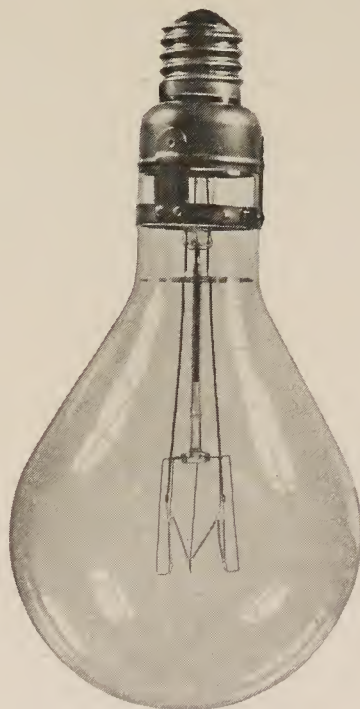
### MAZDA Lamps for Floodlighting

The size of the light source is an important factor in determining the beam spread and efficiency of a reflector. For concentrated beams of less than about 15 degrees spread, there is available the MAZDA Floodlight lamp, characterized by a closely coiled filament, a short light center length, and a round bulb of comparatively small dimensions. This concentrated filament approaches the ideal point source of light, while the small bulb minimizes the amount of light which the reflector directs back through the glass of the bulb, with resulting absorption. Floodlight lamps may be burned in any position except within 45 degrees of the vertical, base up.

For applications requiring a beam spread greater than about 15 degrees, there is no particular advantage in an extremely concentrated light source; the General Service MAZDA lamp, in a pear-shaped bulb and with a relatively large filament, is entirely satisfactory. Not only is the General Service lamp satisfactory in these wider beam spreads, but it also allows for a greater flexibility as regards intensities because a range of wattage can generally be used in any given equipment. Lamps of this type have the further advantages that they may be burned in any position, have a longer rated life, and cost less.



500-watt  
MAZDA Floodlight lamp



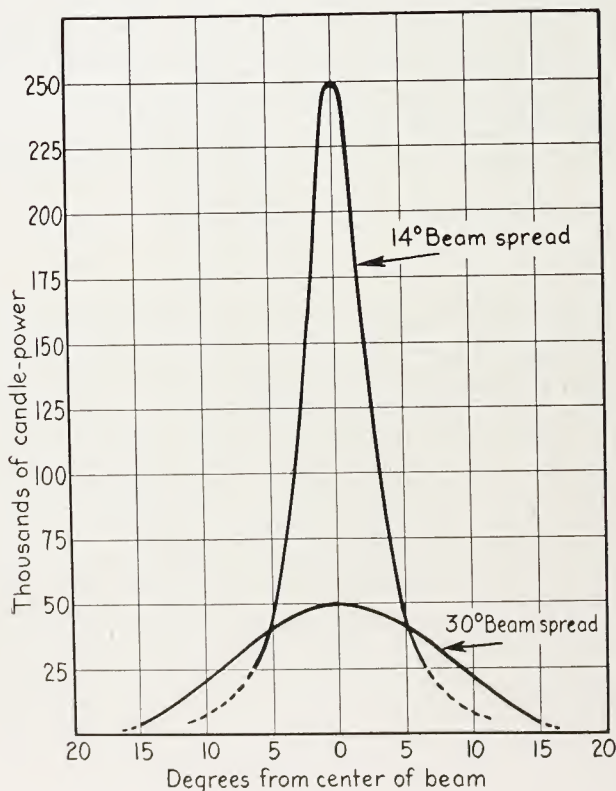
1000-watt  
General Service MAZDA lamp

## FLOODLIGHTING

### Beam Spread

Attention is called to the fact that in referring to the beam of a floodlight the angle is the *total* beam spread in degrees. A floodlight of 30-degree beam spread, for example, is one which has a *total* beam spread of 30 degrees, 15 degrees on each side of nadir. The accompanying sketch illustrates this point.

Furthermore, most manufacturers of floodlighting equipments have agreed that the beam limit of a floodlight should be considered that point at which the beam candlepower is 10 per cent of the maximum beam candlepower. Accordingly they have designed their equipments on this basis, and in stating the beam spread and efficiency of a floodlight, the spill light outside of this angle—that is, beyond this 10 per cent point—is generally disregarded. The reason for disregarding this spill light of low beam candlepower is that it is seldom of any use, except where very large areas are to be lighted or where the projectors are located close to the object to be lighted. Hence, an efficiency based on the *total* light output of a floodlight is a figure which is quite often misleading.



Typical distribution curves of floodlight projectors having narrow and wide beam spreads

The beam limit is that point at which the beam candlepower is 10 per cent of maximum



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## FLOODLIGHTING

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### Reflecting Materials

The three types of reflecting surfaces commonly employed are silvered glass, chromium plate, and polished aluminum. Silvered glass is the most widely used because it possesses the highest initial reflecting efficiency, about 85 per cent, and it also has the very desirable characteristic of maintaining a high efficiency in service. The metal reflectors should be used only where the equipment will be subjected to extremely rough treatment, since the reflecting efficiencies are low in comparison with silvered glass. Among the metals suitable for use as reflecting surfaces, chromium plate is a recent development which will quite likely supersede other metals because of its extreme hardness and its non-corroding properties.

Silver-plated metal reflectors, although possessing a very high initial efficiency, are not practical for floodlighting equipment because the reflecting surface will tarnish unless covered with a protective coating. A protective lacquer has sometimes been used for this purpose, but it has been found that the heat from a high-wattage lamp browns this lacquer coating, thereby reducing its transparency and materially decreasing the efficiency. Nickel plate has also been used as a reflecting surface, but it has a very low initial reflecting efficiency and it tarnishes rapidly.

#### EFFICIENCIES OF REFLECTING MATERIALS EMPLOYED IN FLOODLIGHTING PROJECTORS

| Reflecting Material    | Initial<br>Reflecting Efficiency |
|------------------------|----------------------------------|
| Mirrored glass.....    | 82-88%                           |
| Chromium Plate .....   | 65%                              |
| Polished Aluminum..... | 62%                              |
| Nickel Plate.....      | 55%                              |

In addition to the usual types of floodlights having reflectors of mirrored glass or polished metal, there are other types which give more or less the same effect. One of these employs a Fresnel lens in which refracting prisms redirect the light into a rectangular beam having a relatively sharp cut-off. Another type employs a white diffusing reflector of large area. Although it does not give a well-defined beam, and consequently must be located close to the area to be lighted, it has found rather wide application for lighting large outdoor areas.

### Reflector Contour

In designing a reflector contour, the principal consideration is either minimum beam divergence with a high beam candlepower, or greater beam divergence with a maximum quantity of light in the beam. Within practical limits of reflector diameter, high beam candlepower and maximum quantity of light are inherently conflicting conditions and to a considerable extent one is obtained at the expense of the other.

Minimum beam divergence, as required in the case of searchlights and floodlights of narrow beam spread, is obtained with a shallow reflector of paraboloidal form; the divergence of the beam decreases as the focal length increases. With this design the effective angle—that is, the solid angle of light flux intercepted by the reflector—is limited and the quantity of light in the beam is correspondingly limited. For a given focal length, the diameter of the reflector must be increased in order to increase the effective angle and thereby obtain a greater quantity of light in the beam.

Where greater beam divergence is desired, as in floodlights of medium or wide beam spreads, one should employ not a shallow paraboloid but a deeper reflector, whose surface may depart from the paraboloidal form. Since the reflector is deeper, the effective angle is larger and the quantity of light in the beam is greater. There is a considerable range in the contours which may be utilized, within the limitations of a given diameter and depth of reflector, to produce a desired beam spread. Skill in the design of the contour will be evidenced by uniformity of beam.

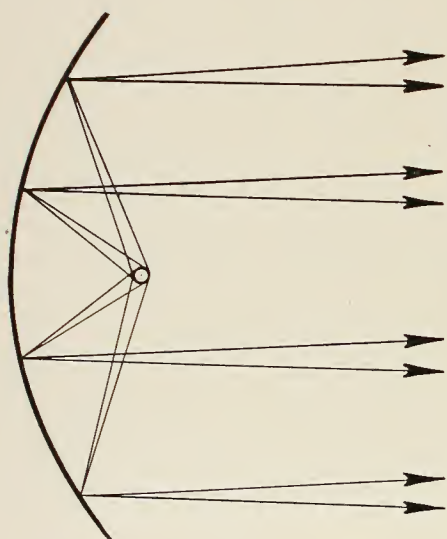
Composite reflectors may also be designed to combine in one reflector two parabolic contours of different focal lengths, or one parabolic and one non-parabolic contour. In the former case a greater efficiency is obtained for a given diameter of projector while the latter design provides a broad beam spread with a fairly high candlepower in the center.

At present it is common practice to design a reflector for a rather definite beam spread, thereby insuring uniformity of beam. However, it is possible to design a reflector whose beam spread can be changed over a wide range by changing the position of the lamp. With a reflector of this type, uniformity of beam is attained only through very skillful design. All projectors, of course, should

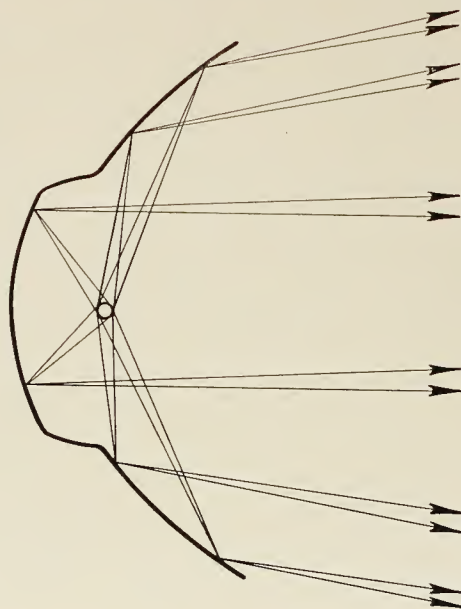


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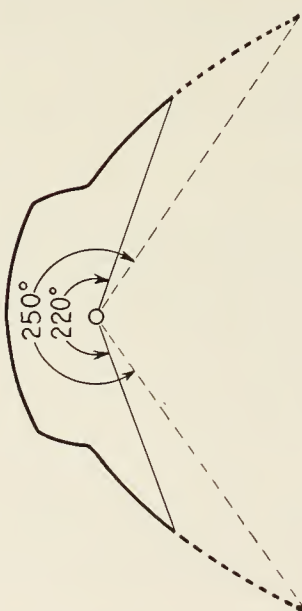
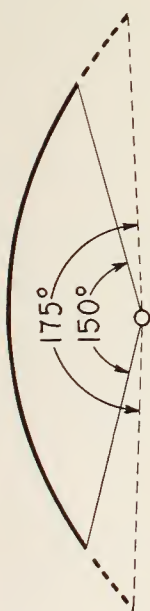
be of such design that in service the lamp may be moved sufficiently, by means of a focusing device, to allow for variations in the construction of individual reflectors and lamps, and to permit increasing or decreasing the normal beam spread over a total range of 5 to 10 degrees.



Parabolic contour for concentrated, accurately controlled beam



Non-parabolic contour for wide-spread beam



Increasing the diameter and depth of either a parabolic or non-parabolic reflector increases the effective angle, and thereby the efficiency

### **Non-Ventilated Units Best**

In the past a great many floodlights have been of the ventilated type, but the present trend is toward non-ventilated weather-tight equipment which is properly designed to dissipate the heat by radiation rather than through ventilation. One sometimes hears the thought expressed that a high temperature of the air around an incandescent lamp shortens its life. However, when it is considered that the filament temperature of the lamps used in floodlighting is well above 4000 degrees Fahrenheit, it is apparent that before excessive heat in a floodlighting unit affects the life of the filament, it will cause trouble at the socket, wire insulation, reflector coating, or lamp base, or will even blister the bulb. These latter factors determine the temperature limit of a floodlight.

It has been found that ordinary bulb glass will soften at around 700 degrees Fahrenheit, while a temperature of about 400 degrees Fahrenheit will generally loosen the basing cement. These temperature limits are high enough to permit equipment to be designed to take care of heat by radiation without increasing the cost of the equipment materially.

Maintenance of the equipment is a matter requiring careful consideration in all floodlighting installations. From this standpoint the advantage of weather-proof and dust-tight units is apparent.

### **Sturdy Mechanical Construction**

The housings of most floodlight projectors were at one time constructed of cast iron or sheet steel or a combination of both. For a number of applications, however, aluminum and copper are now being used in increasing quantities because of their resistance to corrosion.

Focusing mechanisms, permitting adjustments of the lamp position, should be of sturdy construction, simple design, and positive operation. The external adjusting screws on the trunnions and swivel bases should be so designed and constructed that they can be operated by hand, without special tools, under all conditions of service. They should, of course, be of non-corroding material and sufficiently strong to hold the reflector securely in any position.



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## FLOODLIGHTING

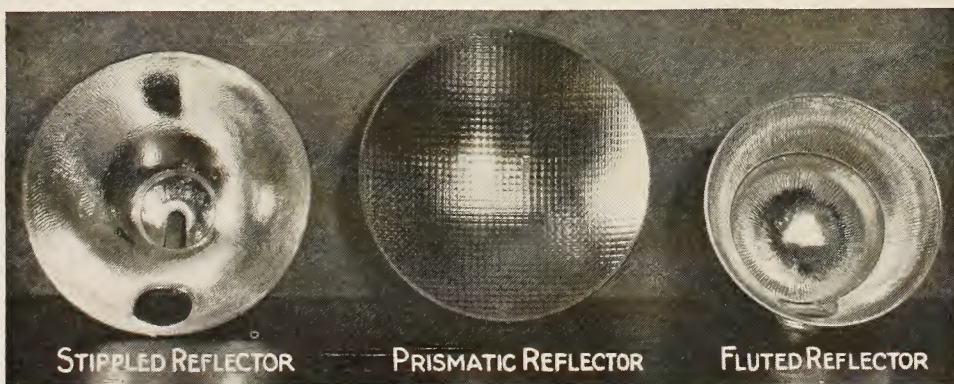
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### Cover Glasses

The ordinary cover glass of a floodlight is of clear, smooth glass, and its primary purpose is to keep dust, dirt, and moisture out of the reflector. Whenever the beam is to be projected above the horizontal, as it is in a great many cases, the cover glass must be sufficiently heat-resisting to prevent cracking from moisture, and care must be taken to insure a water-tight joint between the cover glass and the door. The cover glass also permits the incorporation of color, prisms, and diffusing media, with resulting modifications of the beam. For example, rectangular beams may be obtained by means of fluted or prismatic cover glasses. With a cover glass of this type the efficiency of a floodlight is usually about 10 per cent less than when a clear cover glass is used.

### Methods of Diffusion

Sometimes it is found necessary to increase the beam spread of a given projector for limited applications. This spreading of the beam can be obtained either by frosting or sand-blasting the cover glass or by means of a light stippling. A stippled cover glass absorbs only about 5 per cent more light than a clear cover glass, while the absorption of a frosted or sand-blasted cover glass is somewhat greater and the light is usually spread over a larger area than necessary. Another efficient method of accomplishing this spreading and smoothing of the beam is by means of hammered or stippled reflectors, fluted reflectors, or so-called prismatic reflectors.



For limited applications, where efficiency is not of primary importance, a smoother and wider beam is obtained with these reflectors or with diffusing cover glasses

### Color Equipment

Tinting and coloring of the light may be accomplished by introducing color in the cover glasses or by the use of auxiliary cover glasses or screens. Colored cover glasses, or auxiliary glasses inside the clear cover glass, are of a permanent nature and should be used wherever color is to be employed for any length of time. For temporary use over a period of a few days, as during a carnival, gelatine color screens in a great many tints and shades can be obtained from theatre supply houses.

Colored cover glasses are regularly available in red, green, blue, and amber. These colors offer sufficient variety to meet the requirements of practically all floodlighting applications, but if other tints or shades are desired they can be obtained by the proper combination of floodlights equipped with cover glasses of these standard colors.

Since a high refinement of spectral quality is seldom required in floodlighting, the depth of the coloring in color equipment should preferably be such that the per cent of transmitted light falls within the following values: amber, 40 to 60 per cent; red, 15 to 20 per cent; green, 5 to 10 per cent; blue, 3 to 5 per cent. If colored glasses and color screens are designed with higher transmission values than these, the lighting effect may appear washed out and lacking in colorfulness; if the coloring is deeper, there is too much loss of light for the effect obtained in floodlighting.

Fortunately it is not necessary to compensate completely for the absorption of color equipment by means of increased wattage, as the effectiveness of color offsets to a large degree the reduction in illumination. When lighting with amber, the wattages employed for clear light should be increased about 50 per cent, with red it should be about doubled, with green it should be about tripled, and with blue it should be increased about five times. This range in the wattage requirements is due principally to the range in the transmission values of color equipments, with modifications based upon the different psychological effects and the different penetrating powers of light of various colors.

Glass color caps which clip directly to the lamp bulbs are not recommended for floodlighting. The weight of a large cap may loosen the lamp bulb from the base, especially when the projector is operated in such a position that the lamp bulb is horizontal.



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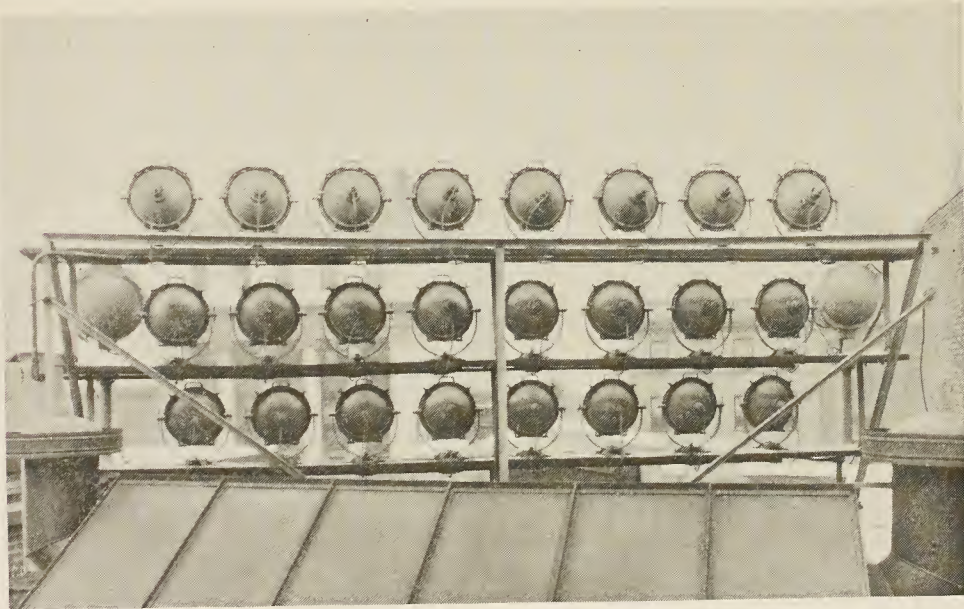
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### EQUIPMENT LOCATION AND MOUNTING

The locations for floodlighting units should be selected so that the desired lighting effect will be obtained, but one is often restricted in the actual positions available. The next few paragraphs present rules of floodlighting design which might almost be called fundamental, together with suggestions on equipment location and mounting.

#### Buildings—Uniform Illumination

Buildings of simple treatment require substantially uniform illumination. This is generally best obtained by locating the floodlights on roofs of buildings directly opposite and not more than 150 or 200 feet away. When the length of building face to be illuminated is not greater than the distance of the floodlights from the building, the units can be placed in one group. Otherwise the units should be divided into two or more groups, thereby obtaining more efficient utilization of the light and avoiding sharp shadows from recessed windows and ledges.



Floodlights directed on the Municipal Gas Building, Albany—A typical bank of projectors for lighting a building uniformly

Small stores, theatres, and other buildings of two or three stories can be lighted quite successfully, when positions across the street are not available, by means of floodlights placed on wide marquees or on ornamental standards set at the curb. The shadows



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are apt to be rather heavy, but by distributing the units as evenly as possible along the front to be lighted, fair uniformity can be obtained. In general, buildings over four stories in height cannot be lighted successfully by marquee or curb post units.



An attractive installation of curb post units for floodlighting the  
St. Louis Ice Cream Company

Whenever a building is to be lighted uniformly, at the top and sides of the building there is always a certain amount of waste light which reduces the computed level of illumination. This loss is compensated for to a considerable extent by the spill light outside of the 10 per cent zone, especially where the projectors are located close to the area to be lighted.

### **Buildings—Non-Uniform Illumination**

Skyscraper architecture lends itself to non-uniform illumination, silhouette, and shadows. Ledges formed by setbacks offer ideal locations for floodlights. The units should usually be placed immediately inside and below the parapet. In northern climates they should be elevated sufficiently above the roof slab to be above drifting snow. Elevation above the roof slab as far as practicable without exposure to view above the parapet also permits easy maintenance and does not subject the units to immersion in trash or rain water. The electrical conduit can be embedded in or mounted on the parapet, or it can be carried by the structure supporting the floodlights. The latter method is cheaper and allows for considerable revision of the lighting installation with little expense.



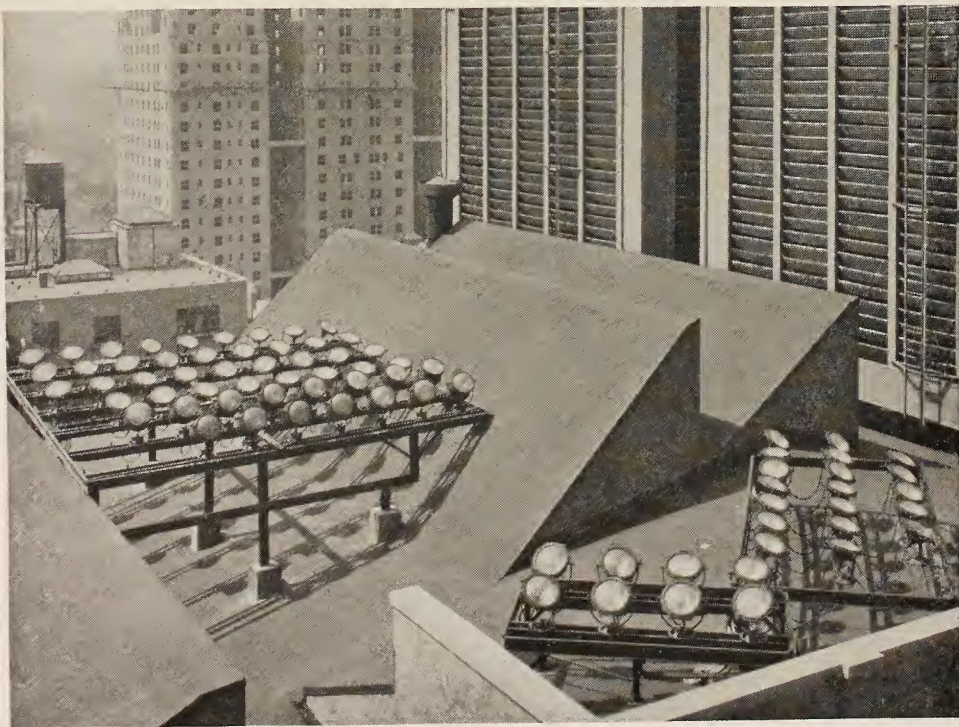
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## FLOODLIGHTING

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Floodlights mounted inside the parapet of the Ohio Bell Telephone Building, Cleveland



Banks of projectors for floodlighting the Paramount Theater Building, New York



### Columns

Where the fronts of columns are to be lighted, leaving the background comparatively dark, the floodlights may be placed on the ledge, between columns, providing the ledge is sufficiently wide to permit the projectors being located far enough forward to light the fronts of the columns with reasonable uniformity. When the lighting is considered along with the building design it is advantageous to provide a space, in front of the columns, where the projectors may be concealed. An ornamental stone or iron grill will accomplish substantially the same result.

Where the dark columns are to stand out in silhouette against a lighted background, the background may be lighted in several ways. If the columns are on the ground floor of the building, the background should be lighted by a row of reflectors concealed behind the lintel or entablature at the top of the columns. If the columns are on an upper floor, the background may be illuminated by floodlights located at the bases of the pillars, or by strips of reflectors on the backs of the columns.

Care must always be taken to locate the floodlights or reflectors far enough back so that scallops of light are not visible on the fronts of the columns.



Dark columns in silhouette against a lighted background

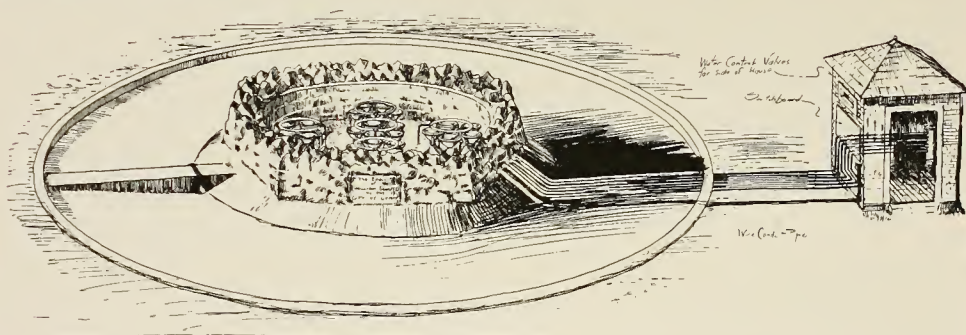


## FLOODLIGHTING

### Fountains

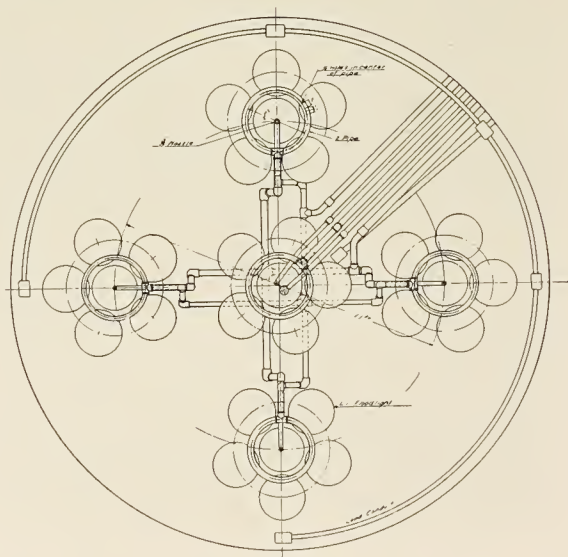
Electric fountains generally utilize floodlighting equipment built into the fountain as an integral part of it. The units are submerged under the spray rings and jets; the beams of light, therefore, travel through the water, making the water itself luminous. This application lends itself to the lavish use of color, with dimming and flashing equipment controlled automatically or manually.

Another type of fountain is one in which the central feature is a sculptured figure with water flowing from it. For lighting this figure, water-tight units may often be concealed in the small basin at the foot of the figure, or in some cases they may be located in the outer retaining wall of the fountain, concealed by carved leaves or scrolls. When light from above is required the floodlights may be mounted in trees or on adjacent posts or structures, but they should be carefully located to avoid objectionable glare.



Above—Arrangement of projectors and controls for Schute Fountain, Lynn, Mass.

Right—Piping and wiring connections for the Schute Fountain

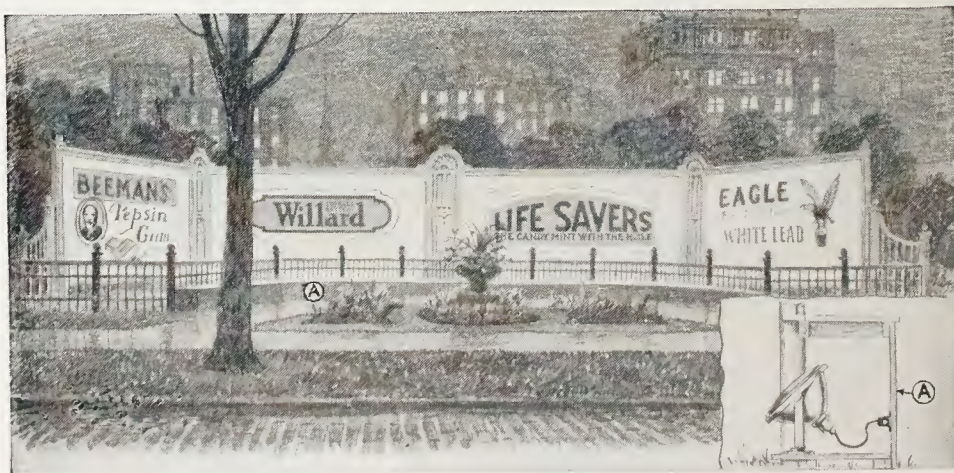


### Statues

In the case of a statue, the lighting should be such as to reveal the beauty and dignity of the statue, without introducing an effect which is grotesque or opposed to that intended by the sculptor. Since most statues are carved to be seen by daylight, coming predominantly from above, it is generally desirable to locate the projectors *above* the statue—on posts, in trees, or on nearby buildings. If such locations are unfeasible, the projectors must be placed somewhere around the base of the statue. In either case, only a few projectors are required and the most satisfactory method of determining the best projector locations is by trial.

### Painted Bulletins and Signs

The present tendency is to make painted bulletins and poster panels more attractive and to beautify the surrounding areas. Where this is done there is a demand for illumination from concealed sources, such as floodlights located in recesses in front of the board or sign and concealed by shrubbery or artistic fencing. Care must be taken to locate the projectors where the reflected light from the board or sign will not be thrown into the eyes of the passers-by; in most cases this means that the light should strike the board rather obliquely. The floodlights should be directed so as to obtain reasonably uniform illumination over the surface of the display. If the distance from the projectors to the display is greater than the length of the display, all the projectors may be grouped together.



Lighting a poster board with floodlights concealed in a trough



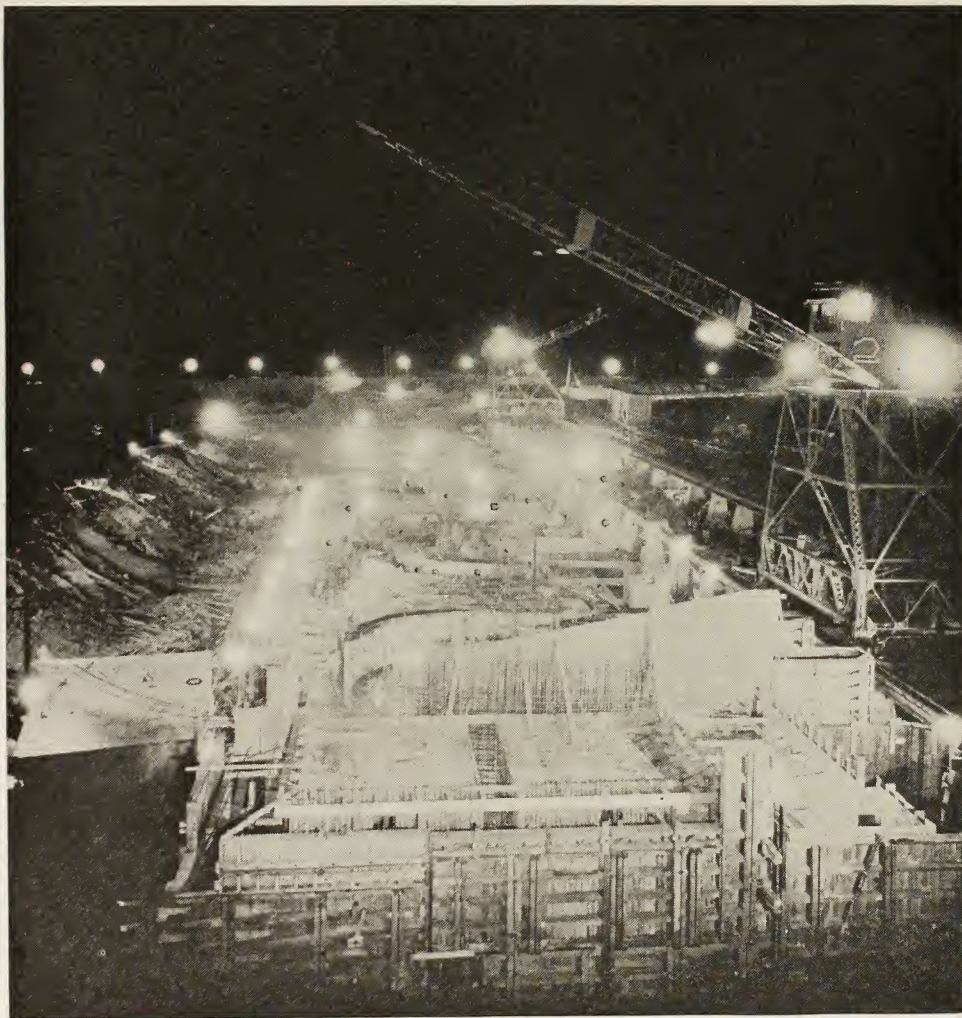
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## FLOODLIGHTING

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### Construction Areas

Construction areas can be lighted by means of projectors located on convenient posts or adjacent buildings, endeavoring to have light come from the directions which will eliminate bothersome shadows and glare. If the major proportion of the light is directed at nearly right angles to the general flow of materials and workmen, a minimum of glare will be encountered. Insofar as possible it should be made unnecessary to look into bright light sources while performing a task; one of the best ways of insuring this is to mount the projectors high above the normal range of vision.



Floodlights permitted construction work on the Louisville Hydro-electric Plant to proceed by night as well as by day



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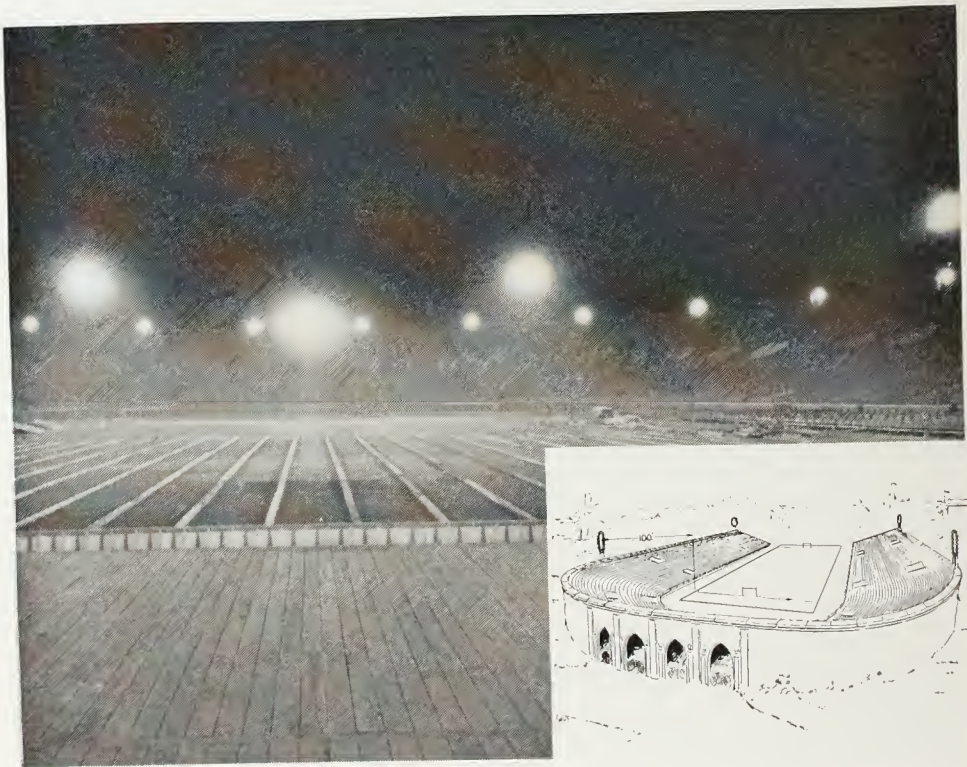
## FLOODLIGHTING

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### Recreational Areas

Recreational areas require substantially uniform illumination with a minimum of glare. Many times these two requirements are conflicting and some compromise is necessary. In general the projectors should be located and the beams should be directed so that at any time the fewest possible number of people need face the units.

Football fields are usually best lighted by two or three banks of floodlights along each side of the field, at a height of at least 75 feet, and not more than 100 feet from the sidelines. Since the direction of play is up and down the field, the players are not subjected to uncomfortable brightness, and by confining the main beams to the playing field the spectators are protected. The locations of the banks of projectors will vary, depending upon the stadium construction. Some stadiums are close enough to the field so that the banks of projectors may be mounted on posts behind the stadium. In other cases, the stadium can be designed to accommodate the lighting equipment in recesses where it will not



In the stadium, floodlighting permits night athletics, carnivals, pageants and community gatherings



## FLOODLIGHTING

obstruct the view of spectators behind it. In general it is not good practice to locate the projectors close to the sides of the field, as this location brings the units more nearly in the line of vision of the players, besides obstructing the view of the spectators not only for night games but also for those played in the daytime.

In parks and playgrounds the projectors should be located so that people using swings, slides, and other attractions are not directly facing light sources. For best results the lighting specialist should take part in the consultation regarding the layout of playground equipment.

The lighting of bathing beaches is usually best accomplished by placing projectors on adjacent structures. When this is not practicable poles should be set at the rear of the beach and at distances apart not greater than 400 feet. Mountings between 30 feet and 50 feet are necessary, bearing in mind that "the higher the better." Light should be directed over the water to the limit of floats, diving piers, and life lines.



Floodlighted beaches mean greater safety and more hours of use



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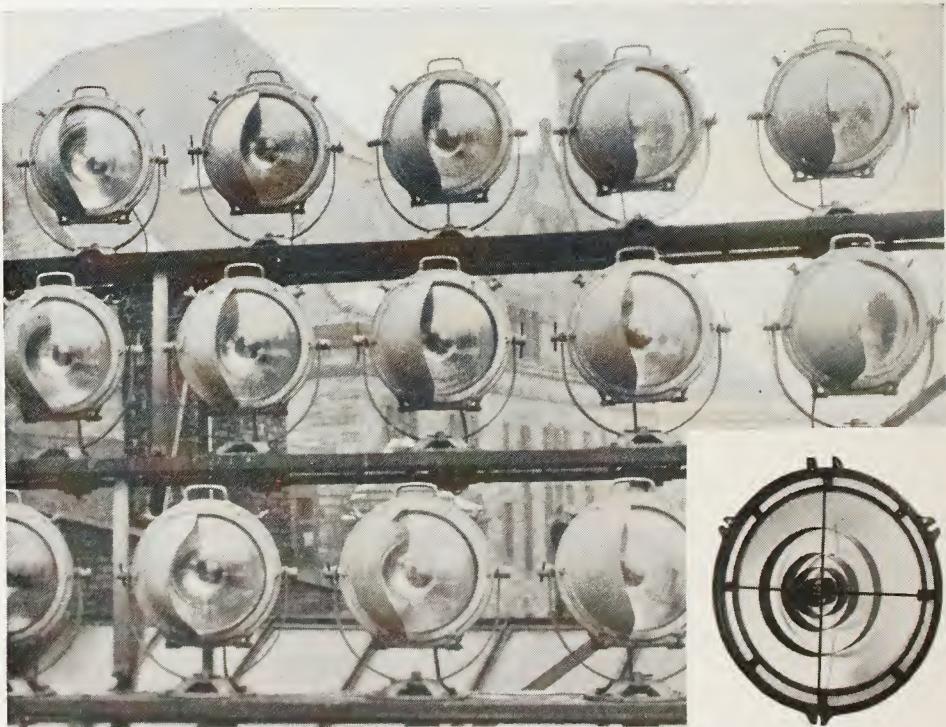
## FLOODLIGHTING

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### Controlling Spill Light

When floodlighting buildings from locations across the street it is essential from the standpoint of people on the street to keep the light above the level of the first floor. Even though the main beam is properly directed, the amount of spill light is sometimes enough to be annoying.

Objectionable spill light must be absorbed or deflected in some manner. Spill rings, if carefully designed, are compact and effective equipment for accomplishing this purpose. However, they absorb quite a proportion of the light from the projectors and therefore they should not be used except where close confinement of the beam is more important than efficiency. A spill shield placed on the inside or outside of the cover glass also serves to cut off spill light in one direction. Another effective and simple means of obtaining a definite cutoff in one direction is a screen built up of sheet metal or wood and placed three to four feet from the projectors to intercept the light below a certain angle. The same kind of a screen can also be employed in a vertical position to cut off spill light which would otherwise be thrown past the edge of a building into a street or area beyond.



A bank of projectors equipped with spill shields  
Insert—A spill ring, for use where close confinement of the beam is required



### FLOODLIGHTING DESIGN PROCEDURE

Just as the architect must follow the rules of proportion and perspective in producing a beautiful structure, so must the designer of a floodlighting installation follow sound engineering practice in such matters as level of illumination and choice of equipment, if the final result is to fulfill expectations.

The following steps comprise the recommended design procedure for floodlighting applications:

1. *Lighting effect*

Decide upon the best lighting effect for the application.

Reference—Effects Sought, page 5.

2. *Level of illumination*

From Table I, on page 28, select the proper foot-candle value for the application.

3. *Location of projectors*

From the projector locations which are available, choose those which will produce the lighting effect decided upon in Step 1.

Reference—Equipment Location and Mounting, page 17.

4. *Beam spread of projectors*

From Table II, on page 29, choose the beam spread which is correct for the application and for the projector locations chosen in Step 3.

Reference—Floodlighting Equipment, page 8.

5. *Type and size of lamp*

The choice of lamp type—that is, General Service or Floodlight—is influenced by several considerations. Projectors employing Floodlight lamps generally have slightly higher beam efficiencies. However, this advantage is offset by the higher lumens-per-watt efficiencies of the General Service lamps, as shown in Table IV, on page 31. In addition, the General Service lamps cost less, have a longer rated life, and can be burned in any position. Although not true in all cases, it is usually advantageous to employ General Service lamps for broad and medium beams, and Floodlight lamps for narrow beams.

Except in unusual applications it is generally more economical to select the largest lamp that can safely be used in projectors of the beam spread chosen.

Reference—MAZDA Lamps for Floodlighting, page 9.

## FLOODLIGHTING

**TABLE I—FOOT-CANDLE RECOMMENDATIONS FOR  
FLOODLIGHTING APPLICATIONS**

### Buildings

| Representative<br>Building Materials | Initial<br>Reflection<br>Factors,<br>Per Cent | Foot-Candles for Downtown* Buildings in<br>Cities of Population: |                 |             |
|--------------------------------------|---|--|-----------------|-------------|
|                                      |   | 50,000 or Over   | 50,000 to 5,000 | Under 5,000 |
| White Terra Cotta.....               | 60-80   | 10   | 8               | 6           |
| Cream Terra Cotta.....               |   |  |                 |             |
| Light Marble.....                    |   |  |                 |             |
| Light Gray Limestone..               | 40-60   | 15   | 12              | 8           |
| Bedford Limestone.....               |   |  |                 |             |
| Buff Limestone.....                  |   |  |                 |             |
| Smooth Buff Face Brick               |   |  |                 |             |
| Briar Hill Sandstone....             | 20-40   | 20   | 15              | 10          |
| Smooth Gray Brick.....               |   |  |                 |             |
| Medium Gray Limestone                |   |  |                 |             |
| Common Tan Brick.....                |   |  |                 |             |
| Dark Field Gray Brick..              | 10-20   | 30   | 20              | 15          |
| Common Red Brick.....                |   |  |                 |             |
| Brownstone.....                      |   |  |                 |             |

\* For buildings in outlying districts use the foot-candles recommended for downtown buildings in cities of the next smaller classification.

NOTE—Buildings composed of material having a reflection factor less than about 20 per cent cannot economically be floodlighted unless there is a large amount of light trim.

### Recreational Areas

| Foot-Candles           |                  |              | Foot-Candles         |                  |              |
|------------------------|------------------|--------------|----------------------|------------------|--------------|
|                        | Good<br>Practice | Mini-<br>mum |                      | Good<br>Practice | Mini-<br>mum |
| Bathing Beaches.....   | 1                | 0.5          | Pageants.....        | 20               | 10           |
| Football Stadiums..... | 12               | 6            | Playgrounds.....     | 4                | 2            |
| Golf Greens.....       | 10               | 6            | Swimming Pools.....  | 6                | 3            |
| Ice Skating.....       | 2                | 1            | Toboggan Slides..... | 2                | 1            |
| Indoor Baseball.....   | 10               | 6            | Trap Shooting.....   | 15               | 10           |

### Utilitarian and Protective Purposes

|                           |    |    |                           |   |     |
|---------------------------|----|----|---------------------------|---|-----|
| Construction Work.....    | 6  | 4  | Parking Spaces.....       | 1 | 0.5 |
| Dredging.....             | 2  | 1  | Protective Industrial.... | 1 | 0.5 |
| Gasoline Service Stations |    |    | Quarries.....             | 4 | 2   |
| Buildings and Pumps       | 15 | 10 | Ship Yards.....           | 6 | 4   |
| Yard and Driveways        | 4  | 2  |                           |   |     |

### Special Applications

|                        |               |    |                         |    |    |
|------------------------|---------------|----|-------------------------|----|----|
| Community Xmas Trees   | 20            | 10 | Signs.....              | 30 | 10 |
| Flags.....             | 25            | 15 | Smoke Stacks.....       | 12 | 8  |
| Loading Docks.....     | 3             | 2  | Stained Glass Windows.. | 30 | 15 |
| Loading Platforms..... | 3             | 2  | Waterfalls.....         | 10 | 5  |
| Monuments.....         | See Buildings |    | Water Tanks.....        | 12 | 8  |



## FLOODLIGHTING

### 6. Choice of projectors

Table V lists representative projectors of various manufacturers according to beam classification, lamp size, and lamp type. Specific beam lumens for any of these projectors may be obtained from the equipment catalogues.

Reference—Floodlighting Equipment, page 8.

### 7. Number of projectors

Use Formula 1 to determine the number of projectors which will produce the required level of illumination.

#### FORMULA 1

$$\text{Number of projectors} = \frac{(\text{Area}) \times (\text{Foot-candles})}{0.7 \times (\text{Beam lumens})}$$

Area—area of surface to be lighted, in square feet.

Foot-candles—from Table 1.

0.7—this represents an allowance of 30 per cent for depreciation in service.

Beam lumens—from Table III where an average value is satisfactory or, for greater accuracy, from equipment catalogues.

**TABLE II—A GUIDE TO THE SELECTION OF  
THE PROPER BEAM SPREAD**

| Representative Floodlighting Applications  | Usual Distance Away | Proper Beam Spread |
|--|---------------------|--------------------|
| Buildings two or three stories high, lighted from marquees or posts at curb..... | 10-30 ft.           | Broad              |
| Buildings lighted from across street or some distance away—                      |                     |                    |
| Areas less than 3,000 square feet.....   | 50-100 ft.          | Medium             |
| Areas more than 3,000 square feet.....   | 50-100 ft.          | Broad              |
| Areas less than 3,000 square feet.....   | 100-150 ft.         | Narrow             |
| Areas more than 3,000 square feet.....   | 100-150 ft.         | Medium             |
| Areas less than 10,000 square feet.....  | 150-300 ft.         | Narrow             |
| Areas more than 10,000 square feet.....  | 150-300 ft.         | Medium             |
| Buildings of the setback type—   |                     |                    |
| Setbacks one or two stories high.....  | On building         | Broad or Medium    |
| Setbacks three or more stories high.....   | On building         | Medium or Narrow   |
| Columns and Ornaments.....   | 2-10 ft.            | Narrow             |
| Construction work, parking spaces, gasoline stations, etc.....                   | At edge             | Broad              |
| Football stadiums.....   | 50-100 ft.          | Medium             |

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## FLOODLIGHTING

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### 8. *Check for uniform coverage*

Where the uniformity is equally as important as the level of illumination, it is necessary to make sure that the number of projectors found from Formula 1 to give the required foot-candle level, is also sufficient to light the surface uniformly. Formula 2 provides this check and shows the number of projectors necessary to cover the building, with sufficient allowance for overlapping.

#### FORMULA 2

$$\text{Number of projectors for coverage} = \frac{\text{Area of lighted surface}}{\text{Average area lighted effectively by each projector}}$$

To determine the number of projectors necessary for uniform illumination, refer to Table VI (Pages 36 to 39) as follows:

(1) Select the table corresponding to the beam spread of the projector chosen in Step 6.

(2) In this table select the values of D and Z which apply to the design being made. Pages 34 and 35 present sketches illustrating the distances designated by D and Z.

(3) The average effective area that will be lighted by one projector is then found under column A. Use this value in Formula 2. The value of A can be obtained by interpolation in case the values of D and Z, as given in the table, do not correspond to the distances in the design being made.

If the number of projectors required for uniform coverage, as found in Formula 2, is greater than the number of projectors required to give the desired foot-candles, as found in Formula 1, uniform illumination will not be obtained. In that case it is necessary to make a new design employing projectors of wider beam spread or more projectors should be used, possibly with smaller lamps. This coverage check should always be made where uniformity is important, even though in the majority of cases the illumination requirements demand a number of projectors more than sufficient for coverage.



## FLOODLIGHTING

**TABLE III—BEAM LUMENS OF TYPICAL FLOODLIGHTING UNITS**

| Beam Spread | Projectors Designed for Floodlight Lamps* |                     | Projectors Designed for General Service Lamps |                              |                                |
|-------------|---|---------------------|---|------------------------------|--------------------------------|
|             | Lamp Size in Watts                        | Average Beam Lumens | Lamp Size in Watts                            | Average Beam Lumens          |                                |
|             |   |                     |   | Reflector<br>Dia. 12" to 16" | Reflector<br>Dia. 18" to 24" † |
| Narrow      | 250                                       | 1100                | 300   | 1400                         | ....                           |
|             |   |                     | 500   | 2500                         | ....                           |
|             |   |                     | 750   | ....                         | 5500                           |
|             | 500                                       | 2600                | 1000  | ....                         | 7800                           |
|             |   |                     | 1500  | ....                         | 10500                          |
| Medium      | 250                                       | 1150                | 300   | 1700                         | ....                           |
|             |   |                     | 500   | 3000                         | ....                           |
|             |   |                     | 750   | 4900                         | 6000                           |
|             | 500                                       | 2800                | 1000  | 7000                         | 8500                           |
|             |   |                     | 1500  | ....                         | 12500                          |
| Broad       | 250                                       | 1200                | 300   | 1900                         | ....                           |
|             |   |                     | 500   | 3400                         | ....                           |
|             |   |                     | 750   | 5200                         | 6200                           |
|             | 500                                       | 2900                | 1000  | 7400                         | 8800                           |
|             |   |                     | 1500  | ....                         | 13000                          |

\* These lamps have concentrated filaments and can be burned in any position except within 45 degrees of the vertical, base up.

† These large units are recommended for long throws, or where the installation will be kept in operation for at least five years, or where there are unusually severe operating conditions.

**TABLE IV  
LUMEN OUTPUTS OF MAZDA LAMPS FOR  
FLOODLIGHTING SERVICE**

|                     | General Service Lamps<br>(Rated Life 1000 Hours) |       |        |        |        | Floodlight Lamps<br>(Rated Life 800 Hours) |       |
|---------------------|--|-------|--------|--------|--------|--|-------|
| Lamp Watts.....     | 300  | 500   | 750    | 1000   | 1500   | 250  | 500   |
| Approximate Lumens. | 5,340  | 9,500 | 14,550 | 20,400 | 32,400 | 3,500                                      | 8,200 |
| Lumens per Watt.... | 17.8   | 19.0  | 19.4   | 20.4   | 21.6   | 14.0                                       | 16.4  |

Note: This table is included for general reference. It is not used in the design procedure given in this bulletin.



Stone Arch Bridge, Minneapolis, Minn.

# FLOODLIGHTING

**TABLE V—REPRESENTATIVE FLOODLIGHTING EQUIPMENTS**  
Narrow Beam Equipment—15° and Less

| Manufacturer                      | Designation      | Reflector              | Lamp Watts | Lamp Type  | Beam Angle |
|-----------------------------------|------------------|------------------------|------------|------------|------------|
| General Electric Co.              | Form L-11.....   | 10½" Smooth.....       | 250        | Floodlight | 15°        |
|                                   | Form L-9.....    | 14¼" Smooth.....       | 500        | Floodlight | 12°        |
| Crouse-Hinds Co...                | SDE-12.....      | 12" Smooth.....        | 250        | Floodlight | 14°        |
|                                   | SDE-16.....      | 16" Smooth.....        | 500        | Floodlight | 9°         |
|                                   | LCE-16.....      | 16" Smooth.....        | 500        | Floodlight | 13°        |
| Curtis Lighting, Inc.             | 25-C.....        | 11" Smooth No. 821.... | 250        | Floodlight | 15°        |
|                                   | 25-C-10527 E. S. | 11" Smooth No. 821.... | 200        | Gen. Ser.  | 15°        |
|                                   | 37-C.....        | 14⅞" Smooth No. 831... | 500        | Floodlight | 15°        |
|                                   | 37-C-10339 E. S. | 14⅞" Smooth No. 831... | 500        | Gen. Ser.  | 15°        |
| Electric Service Supplies Co..... | Type 128.....    | 12" Smooth.....        | 250        | Floodlight | 8°         |
|                                   | Type 1419.....   | 14" Smooth.....        | 500        | Floodlight | 9°         |
|                                   | Type 2430.....   | 24" Smooth.....        | 1000-1500  | Gen. Ser.  | 10°        |
| Pittsburgh Reflector Co.....      | FL-500.....      | 16" Smooth.....        | 300-500    | Gen. Ser.  | 14°        |
| Pyle National Co...               | Type 1045.....   | 10" Smooth.....        | 250        | Floodlight | 12°        |
|                                   | Type 1275.....   | 12" Smooth.....        | 250        | Floodlight | 14°        |
|                                   | Type 1445.....   | 14" Smooth.....        | 500        | Floodlight | 12°        |
|                                   | Type 2375.....   | 23" Smooth.....        | 1000-1500  | Gen. Ser.  | 14°        |
| Westinghouse Co...                | CA-10.....       | 10" Smooth Chromium..  | 250        | Floodlight | 12°        |
|                                   | SA-12.....       | 12" Smooth Chromium..  | 250        | Floodlight | 10°        |
|                                   | CA-14.....       | 14" Smooth Chromium..  | 500        | Floodlight | 12°        |
|                                   | CSA-24.....      | 24" Smooth Chromium..  | 1000-1500  | Gen. Ser.  | 15°        |

**Medium Beam Equipment—16° to 29°**

|                                   |                |                   |           |            |     |
|-----------------------------------|----------------|-------------------|-----------|------------|-----|
| General Electric Co.              | Form L-20..... | 10½" Smooth.....  | 250       | Floodlight | 20° |
|                                   | Form L-22..... | 18¼" Smooth.....  | 1000-1500 | Gen. Ser.  | 20° |
|                                   | Form L-24..... | 18¼" Smooth.....  | 1000      | Gen. Ser.  | 20° |
| Crouse Hinds Co...                | G-250.....     | 11⅞" Smooth.....  | 250       | Floodlight | 23° |
|                                   | G-5.....       | 13⅞" Smooth.....  | 500       | Floodlight | 17° |
|                                   | LCE-12.....    | 12" Smooth.....   | 250       | Floodlight | 20° |
|                                   | LCE-12.....    | 12" Smooth.....   | 200       | Gen. Ser.  | 28° |
|                                   | LCE-16.....    | 16" Smooth.....   | 300-500   | Gen. Ser.  | 26° |
|                                   | LCE-20.....    | 19½" Smooth.....  | 750-1000  | Gen. Ser.  | 24° |
|                                   | LCE-24.....    | 24" Smooth.....   | 1000-1500 | Gen. Ser.  | 22° |
| Electric Service Supplies Co..... | LCE-24.....    | 24" Hammered..... | 1000-1500 | Gen. Ser.  | 24° |
|                                   | Type 918.....  | 9" Smooth.....    | 300-500   | Gen. Ser.  | 24° |
|                                   | Type 1419..... | 14" Smooth.....   | 750-1000  | Gen. Ser.  | 16° |
| Major Equipment Co., Inc.....     | Type 2016..... | 20" Smooth.....   | 750-1000  | Gen. Ser.  | 19° |
|                                   | No. 2540.....  | 11" Smooth.....   | 250       | Floodlight | 18° |
| Pittsburgh Reflector Co.....      | No. 5000.....  | 11" Smooth.....   | 500       | Floodlight | 18° |
|                                   | FLC-500.....   | 16" Smooth.....   | 500       | Gen. Ser.  | 20° |
|                                   | FL-1000.....   | 16" Smooth.....   | 750-1000  | Gen. Ser.  | 27° |



# FLOODLIGHTING

**TABLE V (Continued)—REPRESENTATIVE FLOODLIGHTING EQUIPMENTS**  
**Medium Beam Equipment—16° to 29° (Continued)**

| Manufacturer                           | Designation                                | Reflector                          | Lamp Watts | Lamp Type  | Beam Angle |
|--|--|------------------------------------|------------|------------|------------|
| Pyle-National Co. . . . .              | Type 1275 . . . . .                        | 12" Smooth . . . . .               | 200        | Gen. Ser.  | 17°        |
|  | Type 1260 . . . . .                        | 12" Smooth . . . . .               | 300-500    | Gen. Ser.  | 17°        |
|  | Type 1460 . . . . .                        | 14" Smooth . . . . .               | 750-1000   | Gen. Ser.  | 17°        |
|  | Type 18075 . . . . .                       | 18" Smooth . . . . .               | 1000       | Gen. Ser.  | 28°        |
| Reflector and Illuminating Co. . . . . | Sterling Flood-O-Lite No. 3000 . . . . .   | 11" Smooth . . . . .               | 250        | Floodlight | 18°        |
|  | Sterling Flood-O-Lite No. 5240-C . . . . . | 16" Smooth . . . . .               | 500-1000   | Gen. Ser.  | 24°        |
| Westinghouse Co. . . . .               | CA-10 . . . . .                            | 10" Smooth Chromium . . . . .      | 200        | Gen. Ser.  | 19°        |
|  | CA-14 . . . . .                            | 14" Smooth Chromium . . . . .      | 300-500    | Gen. Ser.  | 20°        |
|  | CA-16 . . . . .                            | 16" Smooth Chromium . . . . .      | 750-1000   | Gen. Ser.  | 16°        |
|  | CA-16 . . . . .                            | 16" "Wide Beam" Chromium . . . . . | 750-1000   | Gen. Ser.  | 29°        |

## Broad Beam Equipment—30° and Over

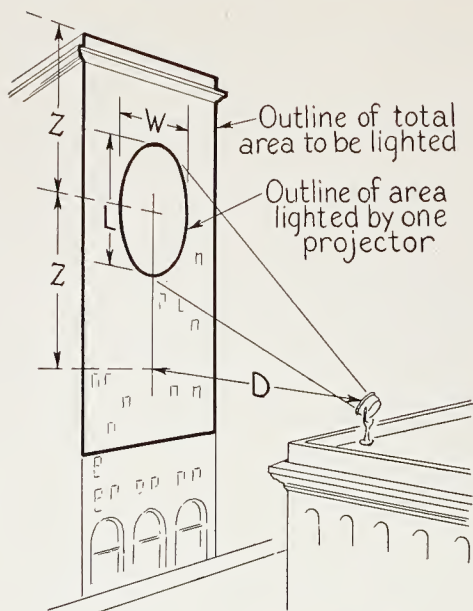
|  |  |                                      |          |            |      |
|--|--|--------------------------------------|----------|------------|------|
| General Electric Co. . . . .           | Form L-20 . . . . .                        | 10½" Smooth . . . . .                | 200      | Gen. Ser.  | 32°  |
|  | Form L-15 . . . . .                        | 15½" Smooth . . . . .                | 500-1000 | Gen. Ser.  | 30°  |
| Crouse Hinds Co. . . . .               | PS-2 . . . . .                             | 11⅞" Hammered . . . . .              | 200      | Gen. Ser.  | 43°  |
|  | PS-5 . . . . .                             | 13⅞" Hammered . . . . .              | 500      | Gen. Ser.  | 36°  |
|  | LCE-12 . . . . .                           | 12" Hammered . . . . .               | 200      | Gen. Ser.  | 46°  |
|  | LCE-16 . . . . .                           | 16" Hammered . . . . .               | 500      | Gen. Ser.  | 32°  |
|  | LCE-20 . . . . .                           | 19½" Hammered . . . . .              | 1000     | Gen. Ser.  | 33°  |
| Curtis Lighting, Inc. . . . .          | 25E . . . . .                              | 11" Corrugated No. 823 . . . . .     | 250      | Floodlight | 110° |
|  | 25E-10527 E. S. . . . .                    | 11" Corrugated No. 823 . . . . .     | 200      | Gen. Ser.  | 110° |
|  | 37E . . . . .                              | 14⅞" Corrugated No. 833 . . . . .    | 500      | Floodlight | 110° |
|  | 37E-10539 E. S. . . . .                    | 14⅞" Corrugated No. 833 . . . . .    | 500      | Gen. Ser.  | 110° |
| Electric Service Supplies Co. . . . .  | Type 1419-P . . . . .                      | 14" Prismatic . . . . .              | 750-1000 | Gen. Ser.  | 34°  |
|  | Type 2016-P . . . . .                      | 20" Prismatic . . . . .              | 750-1000 | Gen. Ser.  | 30°  |
|  | Type 128-P . . . . .                       | 12" Prismatic . . . . .              | 250      | Floodlight | 30°  |
| Major Equipment Co., Inc. . . . .      | No. 2000 . . . . .                         | 11" Smooth . . . . .                 | 200      | Gen. Ser.  | 34°  |
|  | No. 3000 . . . . .                         | 11" Smooth . . . . .                 | 300      | Gen. Ser.  | 46°  |
| Pittsburgh Reflector Co. . . . .       | FL-300 . . . . .                           | 12" Fluted . . . . .                 | 300-500  | Gen. Ser.  | 100° |
| Reflector and Illuminating Co. . . . . | Sterling Flood-O-Lite No. 5240-I . . . . . | 16" Stippled . . . . .               | 500-1000 | Gen. Ser.  | 115° |
| Westinghouse Co. . . . .               | CA-14 . . . . .                            | 14" "Wide Spread" Chromium . . . . . | 300-500  | Gen. Ser.  | 30°  |

NOTE—This classification is based on normal beam spread, to 10 per cent of maximum beam candlepower, with clear cover glass and lamp at focus. Many of these projectors are so designed that by moving the lamp out of focus the beam spread may be increased considerably without losing uniformity of beam. A number of the projectors may also be equipped with diffusing or prismatic cover glasses or reflectors which will give either a wider beam than normally procured, or a definite beam pattern for specific purposes.

## EXPLANATION OF TERMS IN TABLE VI

### Floodlighting Vertical Surfaces—

(1) Where the projectors are directly opposite and at the same elevation as the surface to be lighted.



$D$  = Horizontal distance from projectors to surface to be lighted.

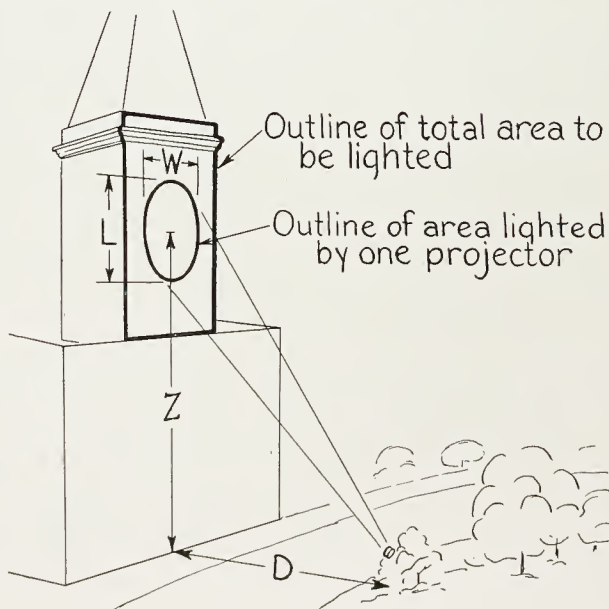
$Z$  = One-half the distance from a point directly opposite the projectors to the farthest edge of the surface to be lighted.

$A$  = Average area lighted effectively by each projector, corrected to allow for overlapping.

$L^*$  and  $W^*$  = Actual length and width of ellipse lighted by each projector.

### Floodlighting Vertical Surfaces—

(2) Where the projectors are *not* directly opposite the surface to be lighted—that is, they may be below the surface, or slightly above or to one side.



$D$  = Horizontal distance from projectors to plane of surface to be lighted.

$Z$  = Distance from a point directly opposite the projectors to the mid-point of the area to be lighted.

$A$  = Average area lighted effectively by each projector, corrected to allow for overlapping.

$L^*$  and  $W^*$  = Actual length and width of ellipse lighted by each projector.

\* See footnote on next page.

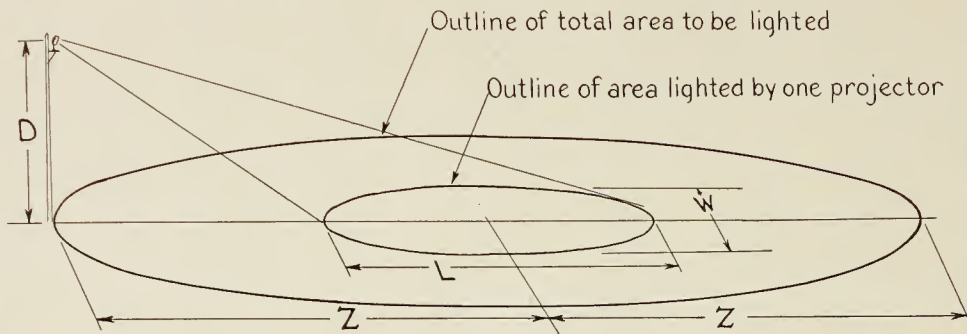


## FLOODLIGHTING

### EXPLANATION OF TERMS IN TABLE VI (Cont.)

#### Floodlighting Horizontal Areas—

(1) Where the projectors are at the edge of the area to be lighted.



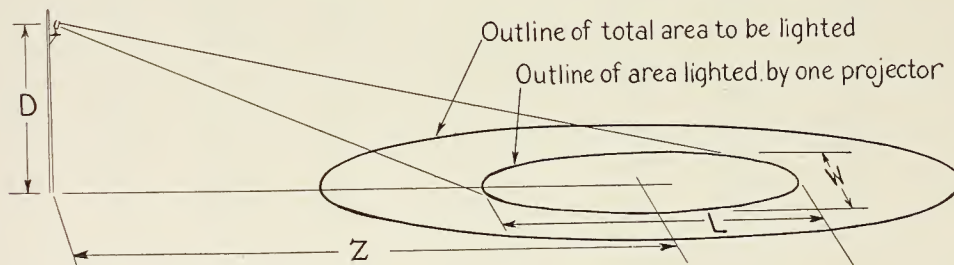
$D$  = Height of projectors above the area to be lighted.

$Z$  = One-half the distance from a point directly below the projectors to the farthest edge of the area to be lighted.

$A$ ,  $L^*$ , and  $W^*$  = Same as given on page 34.

#### Floodlighting Horizontal Areas—

(2) Where the projectors are some distance away from the area to be lighted.



$D$  = Height of projectors above the plane of the area to be lighted.

$Z$  = Distance from a point directly below the projectors to the mid-point of the area to be lighted.

$A$ ,  $L^*$ , and  $W^*$  = Same as given on page 34.

\* The values of  $L$  and  $W$ , as given in Table VI, are *not* used in the regular design procedure. They may be employed in determining the spot size when lighting an architectural detail, or they may be used in laying out the beam patterns over an entire building or area.

# FLOODLIGHTING

TABLE VI  
FINAL CHECK FOR UNIFORM COVERAGE—10° AND 14° PROJECTORS

| 10° Beam Spread Projector |     |      |    |    | 14° Beam Spread Projector |     |      |     |    |
|---------------------------|-----|------|----|----|---------------------------|-----|------|-----|----|
| D                         | Z   | A    | L  | W  | D                         | Z   | A    | L   | W  |
| 15                        | 0   | 5    | 3  | 3  | 15                        | 0   | 8    | 4   | 4  |
|                           | 10  | 8    | 4  | 3  |                           | 10  | 16   | 5   | 4  |
|                           | 20  | 21   | 7  | 4  |                           | 20  | 43   | 11  | 6  |
|                           | 30  | 52   | 14 | 6  |                           | 30  | 110  | 20  | 9  |
|                           | 40  | 113  | 22 | 8  |                           | 40  | 240  | 33  | 11 |
| 25                        | 0   | 11   | 4  | 4  | 25                        | 0   | 21   | 6   | 6  |
|                           | 20  | 23   | 7  | 5  |                           | 20  | 45   | 10  | 8  |
|                           | 40  | 71   | 16 | 8  |                           | 40  | 150  | 23  | 12 |
|                           | 60  | 195  | 31 | 11 |                           | 60  | 440  | 45  | 17 |
|                           | 80  | 450  | 54 | 15 |                           | 80  | 1010 | 82  | 22 |
| 50                        | 0   | 38   | 9  | 9  | 50                        | 0   | 75   | 12  | 12 |
|                           | 20  | 47   | 11 | 9  |                           | 20  | 94   | 15  | 13 |
|                           | 40  | 81   | 14 | 11 |                           | 40  | 160  | 20  | 16 |
|                           | 60  | 150  | 22 | 14 |                           | 60  | 295  | 31  | 20 |
|                           | 80  | 260  | 32 | 17 |                           | 80  | 530  | 46  | 24 |
| 75                        | 0   | 67   | 13 | 13 | 75                        | 0   | 150  | 19  | 19 |
|                           | 40  | 110  | 17 | 14 |                           | 40  | 215  | 24  | 21 |
|                           | 80  | 220  | 28 | 18 |                           | 80  | 470  | 41  | 26 |
|                           | 120 | 530  | 48 | 25 |                           | 120 | 1060 | 68  | 36 |
|                           | 160 | 1040 | 76 | 32 |                           | 160 | 2160 | 110 | 45 |
| 100                       | 0   | 120  | 17 | 17 | 100                       | 0   | 240  | 25  | 25 |
|                           | 40  | 150  | 20 | 19 |                           | 40  | 300  | 29  | 27 |
|                           | 80  | 250  | 29 | 22 |                           | 80  | 510  | 41  | 32 |
|                           | 120 | 470  | 43 | 28 |                           | 120 | 930  | 61  | 39 |
|                           | 160 | 830  | 63 | 33 |                           | 160 | 1730 | 91  | 48 |
|                           | 200 | 1300 | 80 | 42 |                           | 200 | 2910 | 131 | 57 |
| 125                       | 0   | 190  | 22 | 22 | 125                       | 0   | 370  | 31  | 31 |
|                           | 40  | 220  | 24 | 23 |                           | 40  | 430  | 34  | 32 |
|                           | 80  | 320  | 31 | 26 |                           | 80  | 630  | 44  | 36 |
|                           | 120 | 510  | 42 | 30 |                           | 120 | 1010 | 60  | 43 |
|                           | 160 | 820  | 58 | 36 |                           | 160 | 1650 | 83  | 51 |
|                           | 200 | 1300 | 80 | 42 |                           | 200 | 2640 | 114 | 59 |
| 150                       | 0   | 270  | 26 | 26 | 150                       | 0   | 530  | 37  | 37 |
|                           | 40  | 300  | 28 | 27 |                           | 40  | 590  | 40  | 38 |
|                           | 80  | 400  | 34 | 30 |                           | 80  | 780  | 48  | 42 |
|                           | 120 | 570  | 43 | 34 |                           | 120 | 1140 | 61  | 48 |
|                           | 160 | 860  | 57 | 39 |                           | 160 | 1710 | 80  | 54 |
|                           | 200 | 1280 | 74 | 44 |                           | 200 | 2580 | 105 | 62 |
| 200                       | 0   | 480  | 35 | 35 | 200                       | 0   | 950  | 49  | 49 |
|                           | 40  | 510  | 37 | 36 |                           | 40  | 1010 | 51  | 50 |
|                           | 80  | 600  | 41 | 38 |                           | 80  | 1180 | 57  | 53 |
|                           | 120 | 770  | 48 | 41 |                           | 120 | 1520 | 67  | 58 |
|                           | 160 | 1030 | 58 | 45 |                           | 160 | 2000 | 81  | 63 |
|                           | 200 | 1370 | 71 | 50 |                           | 200 | 2700 | 99  | 70 |

The terms in Table VI are explained on pages 34 and 35. All distances in feet.



# FLOODLIGHTING

TABLE VI (Continued)  
FINAL CHECK FOR UNIFORM COVERAGE—20° AND 26° PROJECTORS

| 20° Beam Spread Projector |     |      |     |     | 26° Beam Spread Projector |     |       |     |     |
|---------------------------|-----|------|-----|-----|---------------------------|-----|-------|-----|-----|
| D                         | Z   | A    | L   | W   | D                         | Z   | A     | L   | W   |
| 15                        | 0   | 18   | 5   | 5   | 15                        | 0   | 32    | 7   | 7   |
|                           | 10  | 33   | 8   | 7   |                           | 10  | 56    | 10  | 8   |
|                           | 20  | 93   | 16  | 9   |                           | 20  | 170   | 21  | 12  |
|                           | 30  | 250  | 30  | 13  |                           | 30  | 505   | 44  | 18  |
|                           | 40  | 620  | 55  | 17  |                           | 40  | 1480  | 91  | 25  |
| 25                        | 0   | 44   | 9   | 9   | 25                        | 0   | 75    | 12  | 12  |
|                           | 20  | 100  | 15  | 12  |                           | 20  | 165   | 20  | 15  |
|                           | 40  | 330  | 34  | 17  |                           | 40  | 750   | 47  | 28  |
|                           | 60  | 1030 | 73  | 25  |                           | 60  | 2300  | 113 | 36  |
|                           | 80  | 2920 | 145 | 36  |                           | 80  | 9100  | 289 | 56  |
| 50                        | 0   | 155  | 18  | 18  | 50                        | 0   | 260   | 23  | 23  |
|                           | 20  | 195  | 21  | 19  |                           | 20  | 330   | 27  | 25  |
|                           | 40  | 330  | 30  | 23  |                           | 40  | 590   | 39  | 31  |
|                           | 60  | 630  | 45  | 28  |                           | 60  | 1030  | 61  | 38  |
|                           | 80  | 1160 | 68  | 35  |                           | 80  | 2200  | 95  | 47  |
| 75                        | 0   | 310  | 26  | 26  | 75                        | 0   | 530   | 35  | 35  |
|                           | 40  | 440  | 34  | 30  |                           | 40  | 780   | 45  | 40  |
|                           | 80  | 1010 | 59  | 39  |                           | 80  | 1800  | 79  | 52  |
|                           | 120 | 2320 | 102 | 52  |                           | 120 | 4400  | 143 | 71  |
|                           | 160 | 5050 | 171 | 67  |                           | 160 | 10400 | 254 | 94  |
| 100                       | 0   | 490  | 35  | 35  | 100                       | 0   | 840   | 46  | 46  |
|                           | 40  | 610  | 41  | 38  |                           | 40  | 1070  | 54  | 50  |
|                           | 80  | 1050 | 59  | 46  |                           | 80  | 1850  | 78  | 60  |
|                           | 120 | 2000 | 90  | 56  |                           | 120 | 3590  | 122 | 75  |
|                           | 160 | 3700 | 136 | 69  |                           | 160 | 7000  | 190 | 94  |
| 125                       | 0   | 760  | 44  | 44  | 125                       | 0   | 1310  | 58  | 58  |
|                           | 40  | 890  | 49  | 46  |                           | 40  | 1520  | 64  | 61  |
|                           | 80  | 1300 | 63  | 53  |                           | 80  | 2270  | 83  | 69  |
|                           | 120 | 2130 | 87  | 62  |                           | 120 | 3750  | 117 | 82  |
|                           | 160 | 3540 | 123 | 74  |                           | 160 | 6450  | 167 | 98  |
| 150                       | 0   | 1100 | 53  | 53  | 150                       | 0   | 1890  | 69  | 69  |
|                           | 40  | 1230 | 57  | 55  |                           | 40  | 2100  | 75  | 72  |
|                           | 80  | 1630 | 69  | 60  |                           | 80  | 2800  | 91  | 79  |
|                           | 120 | 2380 | 89  | 68  |                           | 120 | 4150  | 118 | 90  |
|                           | 160 | 3610 | 117 | 79  |                           | 160 | 6450  | 158 | 105 |
| 200                       | 0   | 1940 | 71  | 71  | 200                       | 0   | 3350  | 92  | 92  |
|                           | 40  | 2080 | 73  | 72  |                           | 40  | 3600  | 96  | 94  |
|                           | 80  | 2470 | 82  | 77  |                           | 80  | 4250  | 108 | 100 |
|                           | 120 | 3160 | 97  | 83  |                           | 120 | 5500  | 128 | 109 |
|                           | 160 | 4240 | 118 | 91  |                           | 160 | 7400  | 157 | 120 |
| 200                       | 0   | 5800 | 146 | 102 | 200                       | 0   | 3350  | 92  | 92  |
|                           | 40  | 2080 | 73  | 72  |                           | 40  | 3600  | 96  | 94  |
|                           | 80  | 2470 | 82  | 77  |                           | 80  | 4250  | 108 | 100 |
|                           | 120 | 3160 | 97  | 83  |                           | 120 | 5500  | 128 | 109 |
|                           | 160 | 4240 | 118 | 91  |                           | 160 | 7400  | 157 | 120 |

The terms in Table VI are explained on pages 34 and 35. All distances in feet.

# FLOODLIGHTING

TABLE VI (Continued)  
FINAL CHECK FOR UNIFORM COVERAGE—30° AND 36° PROJECTORS

| 30° Beam Spread Projector |     |       |     |     | 36° Beam Spread Projector |     |       |     |     |
|---------------------------|-----|-------|-----|-----|---------------------------|-----|-------|-----|-----|
| D                         | Z   | A     | L   | W   | D                         | Z   | A     | L   | W   |
| 15                        | 0   | 45    | 8   | 8   | 15                        | 0   | 65    | 10  | 10  |
|                           | 10  | 80    | 12  | 10  |                           | 10  | 120   | 15  | 12  |
|                           | 20  | 240   | 26  | 14  |                           | 20  | 400   | 33  | 18  |
|                           | 30  | 790   | 56  | 21  |                           | 30  | 1600  | 84  | 29  |
|                           | 40  | 2900  | 133 | 33  |                           | 40  | 11500 | 317 | 56  |
| 25                        | 0   | 100   | 13  | 13  | 25                        | 0   | 150   | 16  | 16  |
|                           | 10  | 140   | 16  | 15  |                           | 10  | 190   | 20  | 17  |
|                           | 20  | 220   | 23  | 18  |                           | 20  | 360   | 29  | 21  |
|                           | 30  | 430   | 36  | 21  |                           | 30  | 720   | 47  | 28  |
|                           | 40  | 920   | 59  | 28  |                           | 40  | 1570  | 79  | 36  |
|                           | 50  | 1930  | 94  | 37  |                           | 50  | 3800  | 141 | 48  |
|                           | 60  | 3950  | 155 | 46  |                           | 60  | 10700 | 281 | 68  |
| 50                        | 0   | 350   | 27  | 27  | 50                        | 0   | 520   | 33  | 33  |
|                           | 20  | 450   | 33  | 29  |                           | 20  | 660   | 38  | 35  |
|                           | 40  | 800   | 46  | 35  |                           | 40  | 1210  | 57  | 43  |
|                           | 60  | 1590  | 73  | 44  |                           | 60  | 2540  | 94  | 55  |
|                           | 80  | 3200  | 117 | 56  |                           | 80  | 5600  | 159 | 72  |
| 75                        | 0   | 700   | 40  | 40  | 75                        | 0   | 1030  | 49  | 49  |
|                           | 20  | 790   | 43  | 42  |                           | 20  | 1140  | 52  | 50  |
|                           | 40  | 1060  | 53  | 46  |                           | 40  | 1580  | 65  | 56  |
|                           | 60  | 1590  | 69  | 53  |                           | 60  | 2420  | 86  | 65  |
|                           | 80  | 2480  | 93  | 61  |                           | 80  | 3920  | 118 | 76  |
|                           | 100 | 4000  | 128 | 72  |                           | 100 | 6500  | 166 | 90  |
|                           | 120 | 6400  | 175 | 84  |                           | 120 | 11000 | 235 | 107 |
| 100                       | 0   | 1130  | 54  | 54  | 100                       | 0   | 1660  | 65  | 65  |
|                           | 40  | 1430  | 63  | 58  |                           | 40  | 2130  | 77  | 71  |
|                           | 80  | 2550  | 92  | 70  |                           | 80  | 3870  | 114 | 86  |
|                           | 120 | 5050  | 146 | 89  |                           | 120 | 8100  | 187 | 110 |
|                           | 160 | 10300 | 234 | 112 |                           |     |       |     |     |
| 125                       | 0   | 1760  | 67  | 67  | 125                       | 0   | 2580  | 81  | 81  |
|                           | 40  | 2130  | 73  | 71  |                           | 40  | 3050  | 90  | 87  |
|                           | 80  | 3090  | 97  | 80  |                           | 80  | 4650  | 120 | 99  |
|                           | 120 | 5200  | 138 | 96  |                           | 120 | 8100  | 173 | 119 |
|                           | 160 | 9140  | 200 | 116 |                           |     |       |     |     |
| 150                       | 0   | 2540  | 80  | 80  | 150                       | 0   | 3730  | 98  | 98  |
|                           | 40  | 2880  | 86  | 85  |                           | 40  | 4180  | 105 | 101 |
|                           | 80  | 3820  | 105 | 92  |                           | 80  | 5690  | 129 | 112 |
|                           | 120 | 5700  | 135 | 107 |                           | 120 | 8700  | 179 | 127 |
|                           | 160 | 10300 | 234 | 112 |                           |     |       |     |     |
| 200                       | 0   | 4500  | 107 | 107 | 200                       | 0   | 6600  | 130 | 130 |
|                           | 40  | 4800  | 111 | 109 |                           | 40  | 7050  | 135 | 132 |
|                           | 80  | 5700  | 125 | 116 |                           | 80  | 8500  | 153 | 141 |
|                           | 120 | 7500  | 150 | 127 |                           | 120 | 11200 | 183 | 156 |
|                           | 160 | 10200 | 184 | 141 |                           |     |       |     |     |

The terms in Table VI are explained on pages 34 and 35. All distances in feet.



# FLOODLIGHTING

TABLE VI (Continued)

FINAL CHECK FOR UNIFORM COVERAGE—40° AND 50° PROJECTORS

| 40° Beam Spread Projector |     |      |     |     | 50° Beam Spread Projector |    |      |     |     |
|---------------------------|-----|------|-----|-----|---------------------------|----|------|-----|-----|
| D                         | Z   | A    | L   | W   | D                         | Z  | A    | L   | W   |
| 15                        | 0   | 80   | 11  | 11  | 15                        | 0  | 130  | 14  | 14  |
|                           | 5   | 110  | 13  | 12  |                           | 5  | 175  | 17  | 16  |
|                           | 10  | 150  | 17  | 14  |                           | 10 | 260  | 22  | 18  |
|                           | 15  | 310  | 25  | 19  |                           | 15 | 530  | 33  | 25  |
|                           | 20  | 630  | 43  | 23  |                           | 20 | 1250 | 63  | 30  |
|                           | 25  | 1150 | 65  | 27  |                           |    |      |     |     |
| 25                        | 0   | 185  | 18  | 18  | 25                        | 0  | 305  | 23  | 23  |
|                           | 10  | 240  | 22  | 20  |                           | 10 | 400  | 28  | 26  |
|                           | 20  | 450  | 33  | 24  |                           | 20 | 800  | 44  | 32  |
|                           | 30  | 970  | 55  | 32  |                           | 30 | 2050 | 83  | 44  |
|                           | 40  | 2300 | 98  | 42  |                           | 40 | 6950 | 187 | 66  |
|                           | 50  | 6450 | 194 | 60  |                           |    |      |     |     |
| 35                        | 0   | 320  | 26  | 26  | 35                        | 0  | 520  | 33  | 33  |
|                           | 10  | 380  | 28  | 27  |                           | 10 | 580  | 37  | 32  |
|                           | 20  | 510  | 35  | 32  |                           | 20 | 890  | 47  | 39  |
|                           | 30  | 850  | 49  | 35  |                           | 30 | 1550 | 67  | 47  |
|                           | 40  | 1490 | 71  | 43  |                           | 40 | 3000 | 105 | 59  |
|                           | 50  | 2700 | 106 | 52  |                           |    |      |     |     |
| 45                        | 0   | 470  | 33  | 33  | 45                        | 0  | 780  | 42  | 42  |
|                           | 10  | 520  | 35  | 34  |                           | 10 | 820  | 44  | 42  |
|                           | 20  | 650  | 40  | 37  |                           | 20 | 1070 | 52  | 47  |
|                           | 30  | 890  | 49  | 42  |                           | 30 | 1550 | 67  | 53  |
|                           | 40  | 1320 | 66  | 46  |                           | 40 | 2460 | 91  | 62  |
|                           | 50  | 2100 | 87  | 55  |                           |    |      |     |     |
| 55                        | 0   | 640  | 40  | 40  | 55                        | 0  | 1030 | 51  | 51  |
|                           | 20  | 790  | 46  | 44  |                           | 20 | 1300 | 59  | 56  |
|                           | 40  | 1320 | 66  | 51  |                           | 40 | 2330 | 88  | 68  |
|                           | 60  | 2650 | 104 | 65  |                           | 60 | 5250 | 152 | 88  |
|                           | 80  | 5600 | 172 | 83  |                           |    |      |     |     |
|                           |     |      |     |     |                           |    |      |     |     |
| 70                        | 0   | 1020 | 51  | 51  | 70                        | 0  | 1680 | 65  | 65  |
|                           | 20  | 1180 | 55  | 54  |                           | 20 | 1940 | 72  | 69  |
|                           | 40  | 1680 | 71  | 60  |                           | 40 | 2860 | 93  | 78  |
|                           | 60  | 2700 | 98  | 70  |                           | 60 | 5000 | 135 | 94  |
|                           | 80  | 4700 | 142 | 84  |                           |    |      |     |     |
|                           |     |      |     |     |                           |    |      |     |     |
| 85                        | 0   | 1500 | 62  | 62  | 85                        | 0  | 2460 | 79  | 79  |
|                           | 20  | 1680 | 67  | 64  |                           | 20 | 2750 | 85  | 82  |
|                           | 40  | 2130 | 78  | 69  |                           | 40 | 3600 | 102 | 90  |
|                           | 60  | 3080 | 100 | 78  |                           | 60 | 5400 | 133 | 103 |
|                           | 80  | 4750 | 132 | 92  |                           |    |      |     |     |
|                           | 100 | 7500 | 181 | 106 |                           |    |      |     |     |
| 100                       | 0   | 2100 | 73  | 73  | 100                       | 0  | 3400 | 93  | 93  |
|                           | 20  | 2280 | 78  | 74  |                           | 20 | 3700 | 98  | 96  |
|                           | 40  | 2700 | 86  | 79  |                           | 40 | 4500 | 112 | 102 |
|                           | 60  | 3500 | 104 | 87  |                           | 60 | 7800 | 138 | 113 |
|                           | 80  | 5000 | 130 | 98  |                           |    |      |     |     |
|                           | 100 | 7300 | 168 | 110 |                           |    |      |     |     |

The terms in Table VI are explained on pages 34 and 35. All distances in feet.

## DESIGNING A TYPICAL FLOODLIGHTING INSTALLATION

### Application

Building—Bank in a city of 100,000.

Material—Cream terra cotta.

Building width—75 feet.

Building height—140 feet (120 feet second floor to roof).

### Design Procedure

1. *Lighting effect*

The building is plain and massive, requiring uniform illumination.

2. *Level of illumination*

From Table I, on page 28, 10 foot-candles are required.

3. *Location of projectors*

The best location for equipment is across the street on the roofs of moderately high buildings. Such locations are available on buildings 60 feet high, at a distance of about 90 feet.

4. *Beam spread of projectors*

The area to be lighted is 75 feet by 120 feet, or 9000 square feet. Table II, on page 29, indicates that for areas over 3000 square feet, where the projectors are between 50 and 100 feet away, broad beam equipments should usually be employed. It will be noted that the distance from the projectors to the building—90 feet—is close to the upper limit of the 50-100 foot range. According to Table II, if the distance away is greater than 100 feet medium beam projectors should usually be employed; hence the actual degrees beam spread of the projectors should be close to the dividing line between the broad and medium beam classifications—that is, about 30 degrees.

5. *Type and size of lamp*

Since the beam spread will be broad, it will probably be advantageous to use projectors designed for General Service lamps. For the sake of economy, projectors designed for 1000-watt lamps will be selected tentatively.

6. *Choice of projector*

Table III shows that broad beam equipments are available employing 1000-watt General Service lamps. Further, the table



shows that in addition to the usual projectors 12 to 16 inches in diameter, large projectors in the 18-24 inch class may be obtained. If it is certain that the floodlighting installation will be kept in operation for more than about five years it will pay to figure out whether the higher efficiency of these large projectors will more than offset their higher initial cost. For the purpose of this example, assume that it is required to keep down the initial cost; hence projectors in the smaller-diameter class will be employed.

From Table V and the equipment manufacturers' catalogues, select tentatively a specific projector, of approximately 30 degrees beam spread and employing the 1000-watt General Service lamp.

#### 7. *Number of projectors*

Substitute in Formula 1, on page 29, to determine the number of projectors which will produce the required level of illumination.

$$\text{Number of projectors} = \frac{9000 \times 10}{0.7 \times 7400} = 18 \text{ projectors.}$$

Instead of using the average beam lumens figure of 7400, as taken from Table III, a more accurate result will be obtained by finding from the manufacturer's catalogue the actual beam lumens of the projector tentatively selected.

#### 8. *Check for uniform coverage*

The number of projectors required for uniform coverage is determined in the three following steps:

(1) That part of Table VI which applies to projectors of 30° beam spread is on page 38.

(2) The distance from the projectors to the lighted building—D—is 90 feet; since 90 feet is not listed in this table it will be necessary to interpolate between 75 and 100 feet in Step 3. One-half the distance from a point directly opposite the projectors to the farthest edge of the lighted area—Z—is 40 feet. (See upper sketch on page 34.)

(3) The average area lighted effectively by each projector—A—is then obtained by interpolating between 1060 and 1430; an approximate figure is 1300. Substituting in Formula 2 on page 30:

$$\text{Number of projectors for coverage} = \frac{9000}{1300} = 7$$

This means that 7 projectors would cover the building uniformly. Since the foot-candle requirements necessitate the use of 18 projectors, the design is satisfactory from both standpoints and the projector tentatively selected may be specified definitely.

### RAILWAY CLASSIFICATION YARDS

The lighting of railway classification yards is so new and embodies so many complex features that it warrants a separate discussion.

Economical and satisfactory lighting for railway classification yards is provided by means of floodlighting projectors mounted on high towers at strategic points in the yards. Projectors which have a proper balance between efficiency, beam candlepower, and cost, should be chosen. A high mounting of the projectors is desirable to avoid objectionable glare and to permit long throws of light—a 70-foot tower should be considered a minimum.

In the lighting of railway yards either the distributed system or the group system may be employed. With the distributed system the projectors are distributed throughout the yard at a number of different points, while with the group system the projectors are concentrated at relatively few points. The trend is toward the use of the group system.

There is considerable difference of opinion as to the proper spacing between towers. Until recently yards have had little or no general illumination and tremendous improvements have been obtained by installing lighting towers even at very wide spacings. At present it is common practice to space them 1000 to 2000 feet apart. However, it seems likely that within a few years it will be good practice to space the towers much closer.

There are three general types of classification yards:

1. Yards employing car riders and having hand operated switches.
2. Yards employing car riders and equipped with automatic switches.
3. Yards having no riders but equipped with automatic switches and car retarders.

From the standpoint of illumination design the first two types are essentially the same. For efficient operation at night, sufficient wattage should be employed in lighting these yards to provide



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from 0.1 to 0.2 beam lumens per square foot of yard area. Particular attention must be paid to the location of towers in order to reduce glare to a minimum. Light should usually be directed both with traffic and against traffic to eliminate objectionable shadows and to permit distinguishing cars by silhouette and by glint from the rails—valuable features especially when the atmosphere is foggy or smoke laden. In the uni-directional yard the majority of the light should be directed with traffic; about three-quarters of the light with traffic and one-quarter against traffic is usually an effective distribution, subject to variations depending on local conditions.

Automatic car retarder yards must be provided with a high level of illumination if successful operation is to be attained at night. An average of about 0.5 beam lumens per square foot of yard area is representative of good practice. The most important points in automatic yards are the car retarders and these should have a level of illumination substantially above the average for the yard, with freedom from sharp shadows which might confuse the operators and slow down the operation of the yard.

In general, the light should be so distributed that the operator in the control tower can do three things: first, read the number



Typical projector for floodlighting railway yards

on the car as it passes the control tower in order to check it against his lists; second, see the car, while it is approaching the retarder and while it is in the retarder, with sufficient clearness to judge its speed; and third, see the cars standing at the end of the track so as to judge the speed necessary to carry the car to its destination and make a coupling without damage. Any glare in the operator's eyes will reduce his ability to perform his work, and the tower locations should be chosen with this thought in mind. Local lights with a wide spread mounted on the control tower will most economically provide

the higher intensity necessary at this point if care is taken that it does not become a glare spot for the operators in other control towers.

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For determining the number of projectors necessary to give the required level of illumination Formula 3 should be used.

### FORMULA 3

$$\text{Number of projectors} = \frac{(\text{Area}) \times (\text{Lumens per square foot})}{(0.7) \times (\text{Beam lumens})}$$

Area—area in square feet of the entire yard or of a section of the yard.

Lumens per square foot—0.1 to 0.5, depending upon the yard.

0.7—this represents an allowance of 30 per cent for depreciation in service.

Beam lumens—from Table III where an average value is satisfactory or, for greater accuracy, from equipment catalogues.

The number of projectors obtained by means of the formula above will provide a sufficient number of lumens in the yard for efficient operation. However, the design should include a check to determine whether the number of projectors required for illumination purposes will light the yard with reasonable uniformity. Table VII gives the length and width of the beam pattern for typical railway yard projectors of 14, 20, and 30 degree beam spreads. By using the information given therein, a check of the design is made by plotting on a layout of the classification yard the beam patterns for the individual projectors, with sufficient overlapping to obtain reasonable uniformity. It should be borne in mind that the portion of the ellipse nearest the tower is by far the brightest, while the portion of the ellipse farthest from the tower has a very low level of illumination. Therefore it is usually advisable for the far edge of the ellipse to extend *beyond* the next tower.

Not only is it necessary to use careful design in proceeding with the lighting of the yard, but it is essential that the installation be well maintained. The outside of a cover glass accumulates dirt rather rapidly, and while the majority of the projectors for railway yard lighting are now of weather-proof and dust-tight construction there is always more or less infiltration of dust and smoke. Consequently the reflecting surfaces and the cover glasses should be washed at least once a month.



# FLOODLIGHTING

TABLE VII  
COVERAGE OF RAILWAY YARDS

| 14° Projector |      |     |      |     | 30° Projector |      |     |      |     |
|---------------|------|-----|------|-----|---------------|------|-----|------|-----|
| H             | C    | AP  | L    | W   | H             | C    | AP  | L    | W   |
| 75            | 200  | 180 | 140  | 50  | 75            | 200  | 140 | 240  | 100 |
|               | 400  | 300 | 410  | 90  |               | 400  | 195 | 600  | 160 |
|               | 600  | 370 | 750  | 120 |               | 600  | 220 | 980  | 200 |
|               | 800  | 415 | 1110 | 140 |               | 800  | 230 | 1370 | 230 |
|               | 1000 | 450 | 1480 | 160 |               | 1000 | 240 | 1760 | 260 |
|               | 1200 | 470 | 1910 | 180 |               | 1200 | 245 | 2160 | 290 |
| 90            | 200  | 185 | 120  | 50  | 90            | 200  | 150 | 230  | 110 |
|               | 400  | 320 | 370  | 90  |               | 400  | 215 | 560  | 170 |
|               | 600  | 405 | 690  | 120 |               | 600  | 250 | 940  | 210 |
|               | 800  | 465 | 1040 | 150 |               | 800  | 270 | 1330 | 250 |
|               | 1000 | 510 | 1430 | 180 |               | 1000 | 280 | 1720 | 290 |
|               | 1200 | 540 | 1770 | 200 |               | 1200 | 290 | 2110 | 320 |
| 110           | 200  | 190 | 110  | 50  | 110           | 200  | 160 | 220  | 110 |
|               | 400  | 340 | 330  | 90  |               | 400  | 240 | 530  | 180 |
|               | 600  | 445 | 620  | 130 |               | 600  | 290 | 910  | 230 |
|               | 800  | 520 | 960  | 160 |               | 800  | 315 | 1270 | 270 |
|               | 1000 | 575 | 1310 | 190 |               | 1000 | 330 | 1670 | 310 |
|               | 1200 | 615 | 1680 | 210 |               | 1200 | 340 | 2060 | 350 |
| 20° Projector |      |     |      |     |               |      |     |      |     |
| 75            | 200  | 165 | 180  | 50  |               |      |     |      |     |
|               | 400  | 250 | 500  | 110 |               |      |     |      |     |
|               | 600  | 295 | 860  | 150 |               |      |     |      |     |
|               | 800  | 325 | 1240 | 180 |               |      |     |      |     |
|               | 1000 | 340 | 1600 | 210 |               |      |     |      |     |
|               | 1200 | 355 | 1980 | 230 |               |      |     |      |     |
| 90            | 200  | 170 | 160  | 70  |               |      |     |      |     |
|               | 400  | 275 | 470  | 120 |               |      |     |      |     |
|               | 600  | 335 | 810  | 160 |               |      |     |      |     |
|               | 800  | 370 | 1190 | 190 |               |      |     |      |     |
|               | 1000 | 395 | 1570 | 220 |               |      |     |      |     |
|               | 1200 | 410 | 1910 | 250 |               |      |     |      |     |
| 110           | 200  | 180 | 150  | 80  |               |      |     |      |     |
|               | 400  | 300 | 430  | 130 |               |      |     |      |     |
|               | 600  | 375 | 770  | 170 |               |      |     |      |     |
|               | 800  | 420 | 1110 | 210 |               |      |     |      |     |
|               | 1000 | 455 | 1500 | 240 |               |      |     |      |     |
|               | 1200 | 480 | 1880 | 270 |               |      |     |      |     |

H = Height of projector above the track.

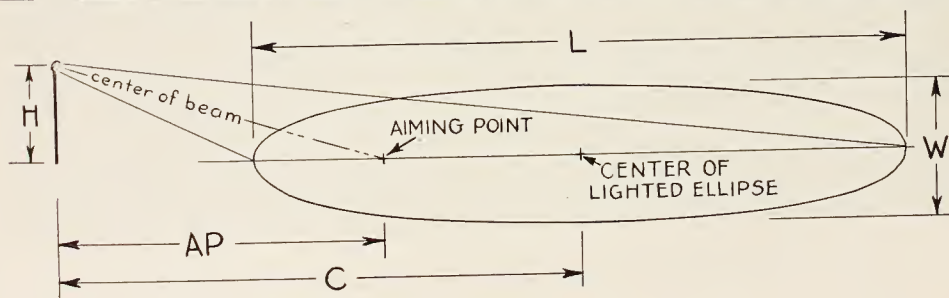
C = Distance from base of tower to the center of the lighted ellipse.

AP = Distance from base of tower to the point at which the center of the beam strikes the ground. This is the point at which the projector should be aimed to obtain the length and width of ellipse as given in the table.

L = Length of ellipse lighted by one projector.

W = Width of ellipse lighted by one projector.

All distances are in feet.



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## FLOODLIGHTING

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Brooklyn Edison Co., Brooklyn, N. Y.



Milwaukee Journal Building, Milwaukee, Wisc.



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## FLOODLIGHTING

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Minute Man, Lexington, Mass.



New York Central Classification Yard, Cleveland, O.



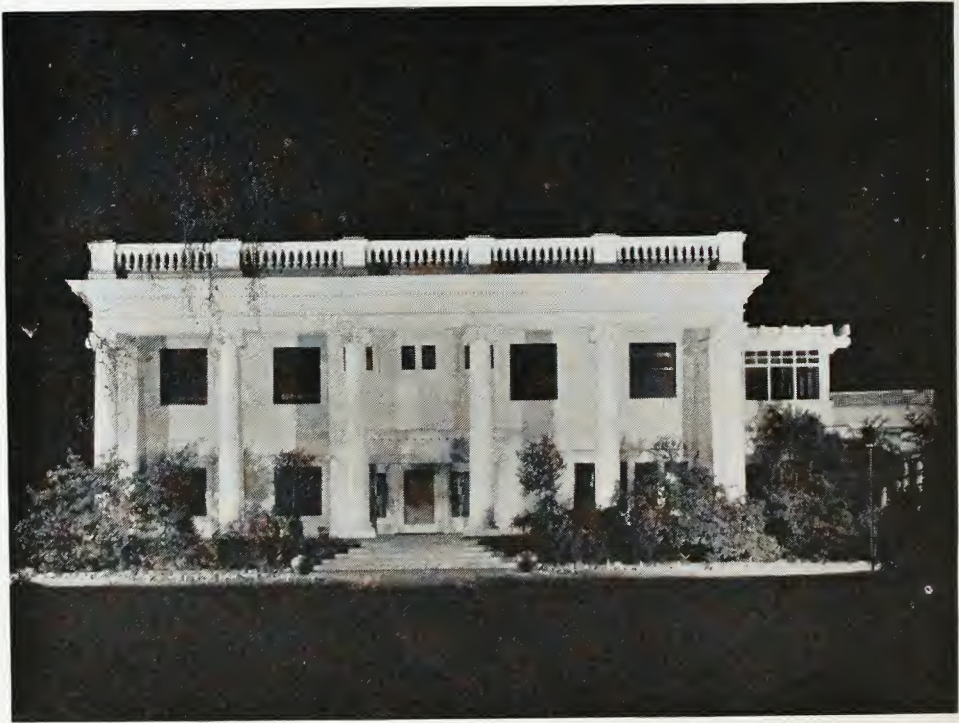
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## FLOODLIGHTING

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Pageant at Wade Park, Cleveland, O.

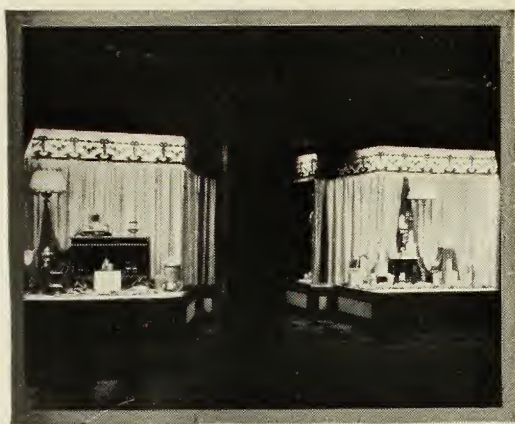


Merritt Manor, Tulare, Cal.

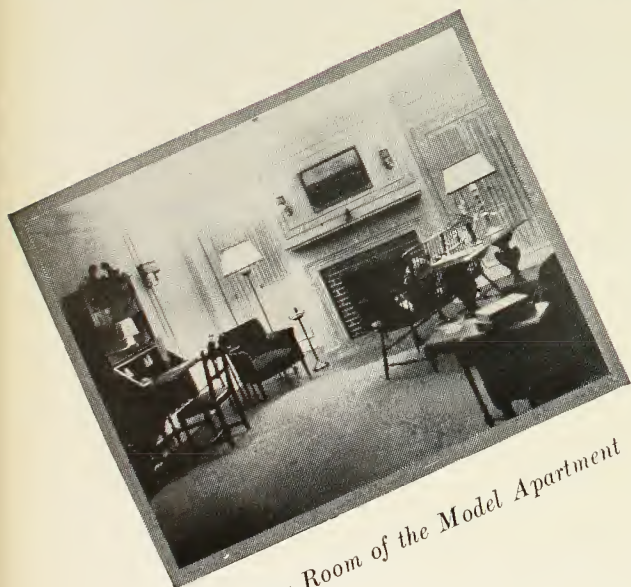




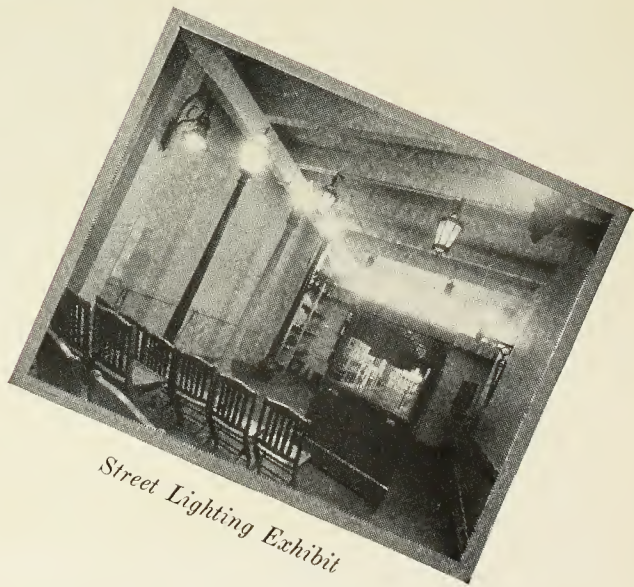
*Auditorium, Showing Miniature Stage and Specially Designed Lighting Units*



*Model Show Windows*



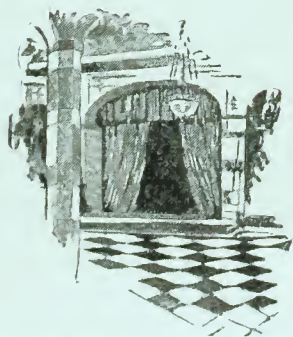
*Living Room of the Model Apartment*



*Street Lighting Exhibit*

Individuals or groups are always welcome. The Institute is open from nine to five every week-day except Saturday. Special arrangements may be made for groups at night. Further details regarding the Institute may be obtained and arrangements for visits made by writing the Edison Lighting Institute, Edison Lamp Works of the General Electric Co., Harrison, N. J., or by telephoning Harrison 8000, extension 380.





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